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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 6372–7371

LUME 56 **OCTOBER 1953** NUMBER 670

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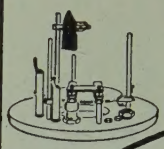

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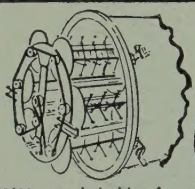

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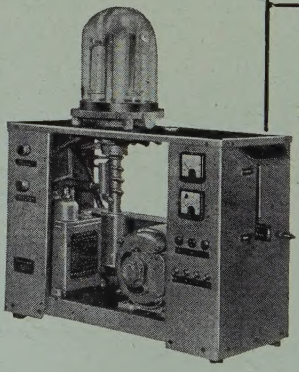

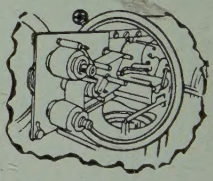

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments	Photocells	Amplifiers
	Thermionic tubes	Radiocommunication
Electronic relays and counters	Cathode-ray tubes	Mechanical engineering
Automatic control mechanisms	X-ray tubes	Illumination
Applied electrochemistry		

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 5123 (1952): *Austral. J. Phys.*, **6**, 124 (*March*, 1953).
Abstr. 6502 (1952): **12**, *No.* 1–3, 160 (1953).
Abstr. 6994 (1952): *Austral. J. Phys.*, **6**, 125 (*March*, 1953).
Abstr. 7222 (1952): **21**, 1312 (*July*, 1953).
Abstr. 10 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 683 (1953): **25**, 799 (*July*, 1953).
Abstr. 952 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 1042 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 1225 (1953): **21**, 1116 (*June*, 1953).
Abstr. 1920 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 1987 (1953): **8**, 137 (*Jan.–Feb.*, 1953).
Abstr. 2192 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 2266 (1953): **25**, 799 (*July*, 1953).
Abstr. 2270 (1953): **25**, 799 (*July*, 1953).
Abstr. 3111 (1953): **21**, 1312 (*July*, 1953).
Abstr. 3399 (1953): **24**, 817 (*June*, 1953).
Abstr. 3929 (1953): **8**, 434 (*May–June*, 1953).
Abstr. 4059 (1953): **90**, 1131 (*June* 15, 1953).
Abstr. 6429 (1953): **90**, 1131 (*June* 15, 1953).

An abstract is only published in *Science Abstracts* when an article or book is believed to be generally available. No abstracts are published of dissertations, reports, or memoranda with limited circulation, unless copies have been deposited with several public libraries; nor of papers presented orally at meetings, unless précis of substantial length are published in the normal way.

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If no indication of language is given in the abstract, the article may be assumed to be in English. This does not necessarily hold, however, for abstracts reprinted from elsewhere, as indicated at the foot of the abstract.

MATHEMATICS 51

51 : 53 : 62

6372. Advanced mathematics in physics and engineering. A. BRONWELL. *London, McGraw-Hill Book Co.* xvi + 475 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 253 (*Aug.*, 1953).

512.831 : 517.941.91

6373. Matrix solution of equations of the Mathieu–Hill type. L. A. PIPES. *J. appl. Phys.*, **24**, 902–10 (*July*, 1953).

Presents a method for the solution of a class of linear, second-order differential equations with periodic coefficients of the Mathieu–Hill type. The method is based on a procedure involving powers of matrices and is adequate for the study of a large class of physical problems. The stability of the solution is considered and the general method is illustrated by its application to typical special cases. A.

513.771 : 548.12

The so-called homology of crystals. *See Abstr.* 7272

517.512.2

6374. The calculation of Fourier series of one or more dimensions with a mechanical synthesizer of new construction. V. CAIMANN AND W. HOPPE. *Z. angew. Phys.*, **5**, *No.* 4, 121–30 (1953) *In German.*

Sine waves of various wavelengths are produced by means of templates of fixed amplitude: different amplitudes are obtained by combining two sine waves of the same frequency in different phases. The components of the Fourier series are added mechanically. The accuracy of the method is discussed, and examples of its use are given. A. R. STOKES

517.512.2.

6375. A simple method for a Fourier analysis. J. M. W. MILATZ, A. H. WAPSTRA AND J. S. VAN WIERINGEN. *Physica*, **19**, 175–80 (*March*, 1953).

A Fourier analysis has been made using only a photovoltaic cell, an alternating current galvanometer and a rotating device. A.

517.512.2

6376. Comments on "The Dirac delta function and the summation of Fourier series." E. R. BERGER. Letter in *J. appl. Phys.*, **24**, 951 (*July*, 1953).

Author lists certain errors claimed to exist in Spiegel [Abstr. 6982 (1952)], in some of these cases the final result is still valid in the conditions treated in Spiegel's paper, but wrong conclusions could be reached in more general cases. It is possible and sometimes easier to solve such equations without the use of Laplace transforms. N. CORCORAN

517.93

6377. A limitation of the reversion method. W. J. CUNNINGHAM. Letter in *J. appl. Phys.*, **24**, 952 (*July*, 1953).

This method is applied to equations of form

$$\sum_{i=1}^{n} Z_i x^i = \lambda f(t)$$

where Z is a differential operator involving t, and λ is a parameter. An approx. solution obtained by methods similar to perturbation is given by Pipes [Abstr. 3201 (1952)] and Cohn and Saltzberg [Abstr. 2894 (1953)]. The author claims that the formulae given in these papers are only correct so long as the solution contains no oscillating terms. N. CORCORAN

517.947

6378. Power-series expansion of the unitary operator $U(t, t_0)$. S. T. MA. *Phys. Rev.*, **91**, 392 (*July* 15, 1953).

The convergence of the iteration process for evaluation of the unitary operator $U(t, t_0)$ is proved for a special case. A.

518.2

6379. Tables of arctan x. Compiled by A. N. LOWAN. *Appl. Math. Ser. Nat. Bur. Stand., No.* 26, 170 *pp.* (1953).

Tables of arctan x are given to 12 significant figures, $x = 0(0{\cdot}001)7(0{\cdot}01)50(0{\cdot}1)300(1)2000(10)10\,000$, together with second differences and auxiliary tables.

G. J. KYNCH

518.5

6380. The principles of programming a calculating machine to play chess. W. SCHLIEBS. *Funk u. Ton*, **7**, 257–65 (*May*, 1953) *In German.*

See also Abstr. 3685 (1950).

518.5

6381. Membrane apparatus for analogic experiments. P. J. SCHNEIDER AND A. B. CAMBEL. *Rev. sci. Instrum.*, **24**, 513–14 (*July*, 1953).

Describes a membrane apparatus which has been used successfully in obtaining analogic soap-film solutions to boundary-value field problems in which either the Poisson or the Laplace partial-differential equation must be satisfied. A.

518.5 : 621.3.011 : 621.317.79 : 621.317.75

6382. The application of the Laplace transformation and a mechanical harmonic synthesizer in the analysis of electric circuits. H. D. SCHWETMAN AND S. L. BROWN. *Rev. sci. Instrum.*, **24**, 375–9 (*May*, 1953).

Specifically, the machine has been used to determine the roots of the polynomial in s (the derivative operator) found in the denominator of the equation $i_k = E_k(s)/D(s)$. In order to achieve this purpose, the mesh currents of several electric circuits, in which the numerical values of the circuit elements were known, were computed by use of the Laplace transformation method in conjunction with the mechanical harmonic synthesizer. In designing a circuit to demonstrate a specified method, it was observed that the character of the roots of the polynomials could be predicted by use of the facts which follow: (1) For every mesh that consists of *R-C* elements or *R-L* elements there is one real root. (2) For every mesh that consists of *R-L-C* elements there are: (*a*) At least one real root when $R/2 > (L/C)^{\frac{1}{2}}$; (*b*) two real roots when $R/2 = (L/C)^{\frac{1}{2}}$; (*c*) two conjugate complex roots when $R/2 < (L/C)^{\frac{1}{2}}$, where R, L and C are the effective values of the resistance, inductance and capacitance of the elements in the mesh. A.

518.5 : 621.317.79

6383. The electronic complex plane scanner. J. R. RAGAZZINI AND G. REYNOLDS. *Rev. sci. Instrum.*, **24**, 523–7 (*July*, 1953).

An electronic analogue computer which scans the complex plane electrically by running a point along the imaginary axis. By so doing, the magnitude of a system function represented by its poles and zeros is obtained. This is accomplished by multiplying a.c. voltages representing the distances from the poles to the running point, multiplying the distances from the zeros to the running point, and then dividing the latt product by the former product. This process mechanized by means of logarithmic networks. E adding a real perturbation to the path of the runnir point, a perturbation of the magnitude of the syste function results. The latter perturbation is show to be proportional to the phase slope. The computin process is done at a high speed so that it is possible t devise various types of oscillographic displays. On form in which both magnitude and phase slope ar simultaneously displayed as a function of frequenc is described in this paper. A

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.2

6384. On the dependence of the mean square fluctuation of phase and amplitude on the dimensions of the objective for the observation of shimmering stars. V. A. KRASIL'NIKOV AND V. I. TATARSKIĬ. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 3, 435–8 (1953) *In Russian.*

A mathematical treatment in terms of atmospheric turbulence giving the values for a square objective. The intensity curve is compared with that found experimentally by Minnaert and Hautgast and shown to be in reasonable agreement. J. M. HOUGH

523.11

6385. On the evolution of stars and chemical elements in the early phases of a galaxy. M. SCHWARZSCHILD AND L. SPITZER, JR. *Observatory*, **73**, 77–9 (*April*, 1953).

It is suggested that when the earliest stars of Population II were formed, the proportion of very massive stars was much greater than is now found either in Population I or in the remaining stars of Population II. This is deduced essentially from an interpretation of three observational facts: the very low abundance of metals in the earliest Population II stars; the high frequency of the white dwarfs; and the excess reddening of distant elliptical galaxies. A. BEER

523.161 : 537.591.1

6386. Kinematic properties of interstellar gas in connection with the isotropic cosmic rays. S. B. PIKEL'NER. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 2, 229–32 (1953) *In Russian.*

A theoretical discussion of the problems of the origin of cosmic rays in interstellar gas and an examination of possible experiments to obtain further data. In particular, the magnetic field, spectroscopic properties, radioastronomy and Fermi's energy formula are considered. J. M. HOUGH

523.165 : 621.396.99

6387. Radio astronomy. M. LAFFINEUR. *Onde élect.*, **33**, 173–81 (*March*, 1953) *In French.*

A summary of the present state of radio astronomy based on discussions at the 1952 general assemblies of the I.A.U. and U.R.S.I., including a statement of the resolutions passed by Commission V (Radio Astronomy) of U.R.S.I. M. W. OVENDEN (R)

523.2

6388. Remarks on Kuiper's cosmogony. E. SCHATZMAN. *Ann. Astrophys.*, **16**, *No.* 3, 179–80 (1953) *In French.*

In Kuiper's theory, protoplanets originate from primary vortices in a solar nebula and develop under the action of tidal forces. The evolution of protoplanets into existing planets is criticized as involving difficulties concerning the conservation of energy and angular momentum. R. A. NEWING

523.36 : 536.2.01

Conduction of heat in a solid with periodic boundary conditions, with an application to the surface temperature of the moon. *See Abstr.* 6695

523.5

6389. Effect of radar sensitivity on meteor echo durations. D. W. R. MCKINLEY. *Canad. J. Phys.*, **31**, 758–67 (*July*, 1953).

Meteor echo durations were observed simultaneously with two radar systems having a power sensitivity ratio of 33 db. An experimental relation between echo duration and system sensitivity is obtained which shows that the duration of meteor echoes varies slowly, but significantly, with system parameters. Curves are furnished to correct observed durations to zenithal durations, applicable to any system using a horizontal half-wave dipole aerial. A.

523.5 : 621.396.9

6390. The length of ionized meteor trails. L. A. MANNING, O. G. VILLARD, JR, AND A. M. PETERSON. *Trans Amer. Geophys. Un.*, **34**, 16–21 (*Feb.*, 1953).

The length is defined as the maximum possible separation of points along the trail from which normal-incidence radio reflections may be obtained, when a radio system of prescribed characteristics is used. A statistical method is employed to determine the relative frequency of trails of different lengths from simultaneous measurements made at two similar 23 Mc/s meteor detection stations 100 km apart. For sixth magnitude meteors, a mean trail length of 25 or 30 km is obtained. A.

523.53

6391. A radar investigation of the delta Aquarid meteor shower of 1950. B.-A. LINDBLAD. *Chalmers Tekn. Högsk. Handl.*, *No.* 129, 26 *pp.* (1952).

Observations were made on 9 m wavelength between July 25th and August 7th. The total echo rate

re no resemblance to the visual meteor rate, but a nilar pattern of activity was found if only the long-ration echoes were considered. A maximum in the te of long-duration echoes on the night of July 28th–th is attributed to the delta Aquarid shower. ourly rates yield a radiant at 340°, −14°, close to e visual radiant. A separation of meteors by size the shower is indicated, which, if attributed to oynting–Robertson effect, would suggest an age of ^{4}–10^5 years for the stream. Using velocity data om McKinley, a short period orbit agreeing closely ith an orbit by Hoffmeister is deduced.

M. W. OVENDEN

523.6

392. The physics of comets. *Mem. Soc. Roy. Sci., iége*, **13**, *No.* 1–2 (1953).

Communications presented at the fourth International Colloquium on Astrophysics held at Liége, 9–21 Sept., 1952.

Introduction by P. Swings. Five chapters: (I) Discovery and photometry of comets; discussion; 30 pp. II) Spectroscopy and spectrophotometry of comets; iscussion; 86 pp. (III) Experimental spectroscopic work; discussion; 55 pp. (IV) Structure of head and ail; relations between solar and cometary phenomena; comparison between cometary atmospheres and the upper atmosphere of the earth; discussion; 63 pp. V) Physical processes concerned with formation and evolution of atmospheres; relations with meteorites; 19 pp. (VI) Origin and evolution of comets; discussion; 49 pp.

For abstracted papers, see abstracts following.

D. R. BARBER

523.6

6393. Photographic photometry of comets. F. Baldet. "*Physics of comets*" *colloquium*, 61–4 [see Abstr. 6392 (1953)] *In French.*

If the comet, together with extra-focal images of a series of near-by stars, are photographed on the same plate, strict comparison of the two is possible provided that the latter are sufficiently degraded to resemble the cometary head. Photoelectric measures of total magnitude agree well with those obtained visually if no traces of tail are present. The p. error lies within ±0·03 mag. If a tail is included in the photographic record large errors are found for the photoelectric method, and, in such cases, visual comparison with the standard stars is to be preferred. Comparison methods involving extra-focal images are simple, do not require complicated apparatus, and yield results of precision similar to that obtained by the Schraffier-kassette technique, the systematic error being <0·05 mag.

D. R. BARBER

523.6

6394. Absolute brightness of comets. J. Bouška. "*Physics of comets*" *colloquium*, 65–9 [see Abstr. 6392 (1953)].

Expressing the absolute brightness H_0 by the relation $H_0 = m - 5 \log \Delta - 2{\cdot}5n \log r$, where Δ denotes the geocentric, and r the heliocentric distance, measures of brightness have been made for 24 comets, 1941–51. The results, with descriptive notes, are tabulated.

D. R. BARBER

523.6

6395. Photometric and spectrophotometric observations of periodic comet Schaumasse. K. M. Yoss. "*Physics of comets*" *colloquium*, 72–85 [see Abstr. 6392 (1953)].

Observations of this comet were obtained with the 24–36 in. Curtis–Schmidt telescope of the Univ. of Michigan. Objective-prism plates in blue and red light respectively were taken between Feb. 22 and April 30, 1952. In addition, three photoelectric tracings in an E–W direction across the cometary nucleus were made with the new Miller photometer attached to the McMath–Hulbert 24 in. telescope. Isophotal contours obtained from the *o–p* exposures reveal significant differences between blue and red images, particularly in the diffuse tail structure, the blue and red tails being inclined ∼9°, the red tail making the larger angle with the prolongation of the radius vector.

D. R. BARBER

523.6

6396. Brightness of comets and solar activity. M. Beyer. "*Physics of comets*" *colloquium*, 276–86 [see Abstr. 6392 (1953)].

Of 44 comets investigated, 32 showed a well-marked dependence of brightness fluctuation on solar activity. The survey included 7 cases unsuitable for analysis on account of sporadic observations; and 8 cases (included above) occurring at sunspot minima which showed either very small or no brightness variation. The existence of the suspected correlation of brightness changes with solar disturbance seems therefore to be established; but the nature of the exciting radiation remains as yet unidentified.

D. R. BARBER

523.6 : 537.591

6397. Meteorites and cosmic rays. S. F. Singer. "*Physics of comets*" *colloquium*, 339–49 [see Abstr. 6392 (1953)].

Meteorites may be used as integrating cosmic-ray meters by virtue of the fact that cosmic rays produce within their substance measurable amounts of He^3 during their flight through space; whereas the He^4 content is due entirely to radioactive meteoritic material. The technique of separating the two isotopes has been applied to 5 typical samples; and from a study of the isotopic He ratios it is apparent, assuming constant cosmic-ray intensity with time, that the parent bodies did not lose a very large fraction of their initial mass in traversing the earth's atmosphere. This result is contrary to expectation, and may necessitate a reconsideration of some aspects of the theory of thermal transfer at great velocities. See also Abstr. 4182 (1953).

D. R. BARBER

523.6

6398. Accretion and the origin of comets. H. Bondi. "*Physics of comets*" *colloquium*, 372–6 [see Abstr. 6392 (1953)].

It is shown, for an initially collision-free flow of matter in a cloud of particles, that neither planetary perturbations nor variations of density and velocity within the cloud can inhibit the accretion process. The collision-free flow being unstable, the probability of collisions occurring will increase progressively with the result that an accretion stream will build up, and persist. Since this accretion stream is highly unstable,

the material falling towards the sun will tend to form conglomerate clouds. Those formed of gas molecules will escape detection; but the major aggregates of dust particles will be observed as comets. D. R. BARBER

523.6

6399. Notes on the Lyttleton theory of comets. W. H. McCrea. "*Physics of comets*" *colloquium*, 377–90 [see Abstr. 6392 (1953)].

Assuming Lyttleton's mechanism (1948) to be operative for a dust cloud of non-uniform density and velocity, it is shown that (1) if either density or velocity varies by an amount ~100% over distances ~0·1 parsec, then the material from which the comet is formed will be endowed with angular momentum of requisite amount; (2) the present discrepancy between theory and observation regarding the distance of the point of origin of the solar family of comets, viz. 1000 a.u. (Lyttleton) and 50 000 a.u. (Oort) may be removed by using a slightly modified form of Lyttleton's theory. D. R. BARBER

523.6

6400. Comets and the dissipation of the solar nebula. G. P. Kuiper. "*Physics of comets*" *colloquium*, 401–25 [see Abstr. 6392 (1953)].

A critical examination of the solar nebula theory of origin of the solar system with particular reference to the mechanism whereby, subsequent to the formation of the protoplanets, the remanent gaseous material was swept out, and the protoplanets evaporated into interplanetary space. The time required for the evaporation of proto-Earth was $\sim 10^8$ yr and that for the dissipation of the interplanetary material would be similar, certainly no less. The effects of (1) density distribution within the sphere containing the planets; (2) the u.v. solar radiation; (3) the solar corpuscular radiation; and (4) evaporation are considered. It is concluded that since, in all probability, effect (3) dominated the dispersal of the solar nebula; the further study of comets, as probes of interplanetary radiations out to great distances from the sun, will increasingly throw light on the processes that shaped the planetary system.

D. R. BARBER

523.63

6401. Inferences on the origin of comets derivable from the distribution of the reciprocal major axes. J. H. Oort. "*Physics of comets*" *colloquium*, 364–71 [see Abstr. 6392 (1953)].

Current observations (i.e. within the last 100 years) make it appear probable that comets come at present from distances ~40 000 a.u. yet belong to a family associated with the solar system. The evidence excludes the possibility that they come directly from either eruptions of Jupiter, accretion, or condensation of matter in the principal part of the solar system, although it is likely that they were formed initially in one of the three ways mentioned above, but were subsequently removed to the extremely rarefied interstellar medium in which they are now moving.

D. R. BARBER

523.66

6402. On the icy conglomerate model for comets. F. L. Whipple. "*Physics of comets*" *colloquium*, 321–8 [see Abstr. 6392 (1953)].

A progress report of the various investigations being undertaken at the Harvard College Observatory, Cambridge, Mass., U.S.A., and dealing specifically with problems of the nature of comets, their development, and their relationships with interplanetary (meteoritic) material. D. R. BARBER

523.6

6403. The structure and evolution of cometary nuclei. E. Schatzman. "*Physics of comets*" *colloquium*, 353–63 [see Abstr. 6392 (1953)] *In French.*

A discussion of the dynamical equilibrium of the nucleus of a comet regarded as a cloud of discrete particles of matter under the influence of Newtonian attraction shows, under certain defined conditions, that dispersion, as opposed to condensation of the material, can result. Equally, the cloud can become impoverished by loss of its constituent particles without either condensation or dispersion taking place.

D. R. BARBER

523.66

6404. Some notes on the fountain model of cometary envelopes and streamers. A. D. Fokker, Jr. "*Physics of comets*" *colloquium*, 241–59 [see Abstr. 6392 (1953)].

A critical discussion of the "fountain" theory first proposed by Eddington (1910). Theoretical streamer patterns are derived, and compared with the observed patterns for 3 comets, viz. Daniel (1907), Beljawsky and Brooks (1911). It is concluded that although the "fountain" theory is likely to be the basis of a model capable of demonstrating the observed behaviour and form of cometary envelopes and streamers, the lack of agreement between observed and computed brightness distributions weighs heavily against the simple "fountain" model. D. R. BARBER

523.663

6405. On the structure of the CO^+ tails in comets. K. Wurm. "*Physics of comets*" *colloquium*, 260–75 [see Abstr. 6392 (1953)].

In the great majority of comets having strong production of CO^+ in the tail region this molecule forms a tail pattern of parabolic envelopes, concentric with the nucleus. There appears no evidence for the widespread belief that in tail structures the repulsive forces are always extremely high ($\sim 10^3\,g$). In an example discussed, a value $\sim 50\,g$ is found.

D. R. BARBER

523.663

6406. Physical processes in comet tails and their relation to solar activity. L. Biermann. "*Physics of comets*" *colloquium*, 291–302 [see Abstr. 6392 (1953)].

An account is given of the dynamics of encounters of cometary material with solar corpuscular streams on the assumption that the tails of comets can be regarded as test-objects for assessing solar (corpuscular) activity. It is shown that the observed rapid variations of CO^+ density with time requires an excess of $\sim 10^8\times$ solar Lyman continuum, which is most unlikely. An alternative mechanism based on the exchange of electrons between solar protons and cometary molecules is suggested as an effective ionizing medium. D. R. BARBER

523.663

6407. On the origin of comets' tails. R. A. Lyttleton. "*Physics of comets*" *colloquium*, 391–400 [see Abstr. 6392 (1953)].

Regarding a comet as a swarm of widely separated

mall particles; simple dynamic principles lead to the evitability of a small proportion of these particles illiding at each perihelion passage with sufficient omentum to pulverize the individual particles, and release material for tail formation. Similar asoning leads also to a cause for the observed anges in dimensions of comets approaching and ceding from the sun. D. R. BARBER

523.67

408. The B-spectrograph of the McDonald Obervatory and its use for cometary spectra. T. L. PAGE. "*Physics of comets*" *colloquium*, 89–91 [see Abstr. 6392 953)].

By means of a small, fast spectrograph incorporating n $f0{\cdot}65$ solid Schmidt camera at the prime focus of ne 82 in. McDonald reflector, infrared spectra of omets have for the first time been obtained which now hitherto unknown features, e.g. a bright band at 906 Å, probably the (2,0) band of CN, $\Pi^2 - {}^2\Sigma$. pectra of Comet Bester (1947k), taken with slit axis long tail, showed 13 bands of CO^+, the relative ntensities being consistent with a rotational temerature of 300° K. They also revealed for the first ime bands of CO_2^+. It was found also that, for eliocentric distances, $0{\cdot}8$ to $1{\cdot}5$ a.u., certain undentified band-features at 4050 Å showed little change f intensity, whilst others, e.g. CN and C_2 bands, lecreased rapidly in intensity with increasing distance rom sun. D. R. BARBER

523.67

6409. Interpretation of the emission spectrum of OH from comets. J. HUNAERTS. "*Physics of comets*" *colloquium*, 99–136 [see Abstr. 6392 (1953)] *In French.*

A theoretical analysis of the general mechanism of fluorescence in the production of emission bands, and, in particular, a study of the structure of OH band-spectra in comets. Consideration is given to the influence of Fraunhofer absorption lines on the energy distribution in the continuum of cometary spectra. Synthetic rotational and vibrational band spectra are derived from computed transition probabilities, and line-intensities. Tables of identifications for OH bands (0–0) and (1–1) of the $A^2\Sigma^+ - X^2\Pi_i$ system are included. D. R. BARBER

523.67 : 535.338.4

6410. New vibrational transition probabilities for the C_2 Swan bands. A. A. WYLLER. "*Physics of comets*" *colloquium*, 137–44 [see Abstr. 6392 (1953)].

Improved theoretical values for vibrational transition probabilities are computed and tabulated, along with two separate experimentally-determined sets, for the more important sequences of the C_2 Swan bands. D. R. BARBER

523.67 : 535.338.4

6411. Application of calculated band intensities to the examination of observed spectra. M. E. PILLOW. "*Physics of comets*" *colloquium*, 145–55 [see Abstr. 6392 (1953)].

Exact calculation of the transition probabilities or band-intensity values requires accurate knowledge of the form of the wave function involved, and the means of integrating these. Recently, approximation methods have been evolved which yield "synthetic" spectral intensities of sufficient accuracy to construct calibration spectra. A modified form of the "distortion" process used to obtain the requisite waveforms has been worked out by the author, and applied to a study of the Swan C_2 bands. It is found that the results agree well with observation, and the method is simpler and more rapid than others recently described. D. R. BARBER

523.67 : 535.338.4

6412. A comparison of observed and calculated intensity profiles for the C_2 Swan bands in cometary spectra. A. MCKELLAR AND J. L. CLIMENHAGA. "*Physics of comets*" *colloquium*, 156–72 [see Abstr. 6392 (1953)].

Main results from this study of the (0, 0) and (1, 0) band sequences are: (1) the intensity-profiles in the spectra of 3 comets obtained at heliocentric distances, $0{\cdot}48$–$1{\cdot}48$ a.u. indicate lower excitation temperature at greater heliocentric distance; (2) intensity-profiles computed on the basis of solar-excited fluorescence give good agreement with the observed profiles; the temperature deduced from molecular distribution among levels of the normal electronic state being $\sim 2000°$–$3000°$K. D. R. BARBER

523.67 : 535.338.4

6413. A study of the band spectra of N_2^+, NO and NO^+ in the Schumann region using N^{15}. E. MIESCHER. "*Physics of comets*" *colloquium*, 177–80 [see Abstr. 6392 (1953)] *In French.*

Spectrograms of the discharge in N^{15}-enriched gas-He mixtures reveal isotopic displacement of certain bands, and thus allow of definitive vibrational analyses of N_2^+ and NO systems. A new band system of NO^+ is described, and wavelengths of observed band heads (degraded towards red) are tabulated. Three isotopic doublets were observed. D. R. BARBER

523.67 : 535.338.4

6414. Band spectrum of CO^+. The Baldet–Johnson system ($B^2\Sigma$—$A^2\Pi$). K. N. RAO AND K. S. SARMA. "*Physics of comets*" *colloquium*, 181–6 [see Abstr. 6392 (1953)].

An extension of 2 previous investigations [Abstr. 4832, 6959 (1950)]. The present work deals with the intercombination bands of the $B^2\Sigma$—$A^2\Pi$ transition. D. R. BARBER

523.67

6415. The cometary emission near 4050 Å. B. ROSEN. "*Physics of comets*" *colloquium*, 187–203 [see Abstr. 6392 (1953)] *In French.*

A factual survey of present knowledge concerning the unidentified emission band observed at 4050 Å in the spectra of late N-type stars, comets and in electrical discharges in H, He and admixed organic vapours. Identification is not as yet possible; but it is likely that the band feature is due to a polyatomic molecule. D. R. BARBER

523.67

6416. The spectrum of NH_3 and the spectrum of comets. P. PROISY. "*Physics of comets*" *colloquium*, 204–30 [see Abstr. 6392 (1953)] *In French.*

A detailed comparison of the spectral emissions due to the molecule NH_3 under a variety of excitation conditions with those seen in cometary spectra, wavelengths 4200–5000 Å. Tables of wavelengths and

identifications include those for comets: Peltier (1936a); Whipple (1937b); Wilk (1937c); and Encke (1937h). D. R. BARBER

523.67 : 535.338.4

6417. On a new spectrum attributed to the C_2H_x molecule ($x = 1$, 2 or 3). H. SCHÜLER. "*Physics of comets*" *colloquium*, 231–5 [see Abstr. 6392 (1953)].

This unidentified spectrum in the visual region shows coincidence of band structure with certain emission features in cometary spectra. D. R. BARBER

523.67 : 551.593.9

6418. A comparison of spectra of comets and of the earth's upper atmosphere. D. BARBIER. "*Physics of comets*" *colloquium*, 303–16 [see Abstr. 6392 (1953)] *In French.*

The mechanism of excitation of certain emission lines and bands, e.g. Na I, N_2^+ and OH, in the spectra of comets at close approach to the sun is compared with those responsible for the production of night-sky, auroral and crepuscular emissions. Unlike the excitation process in aurorae and the night sky, the cometary emissions are due to fluorescence, and therefore are akin to that producing the twilight emission spectrum. However, the observations suggest that for N_2^+ to be excited in this way, the production of the necessary ions may be quite different in cometary matter, and twilight atmosphere respectively, viz. by u.v. radiation, 800 Å (Wurm, 1943) for the former; and by coronal X-radiation (Bates and Nicolet, 1949) for the latter. D. R. BARBER

523.67 : 535.338

6419. Potential energy of the triatomic molecule C_3 and the origin of the 4050 Å group in cometary nuclei. R. GOUPIL. *C.R. Acad. Sci.* [*Paris*] **236,** 1542–4 (*April* 20, 1953) *In French.*

An approximate calculation of the energies of the C_3 molecule gives a wavelength of 4050 Å for the electronic transition (AAX)–(XXA), thus affording some support to Douglas's suggestion of C_3 as a possible source of the 4050 emission band in cometary spectra. D. L. EDWARDS

523.7

6420. Is the general magnetic field of the sun measurable? K. O. KIEPENHEUER. *Z. Naturforsch.*, **8a,** 225–7 (*April*, 1953) *In German.*

Survey of the Zeeman-effect measurements on Fraunhofer lines, and discussion of the magnetic properties of solar material. It is pointed out that, because of the good conductivity of this material, the magnetic lines of force might be considered as an intrinsic property of the solar matter, and as such participate in its convective movements. Measurements will only show the mean value of this "fluctuating micro-field." An inner general magnetic field will only be able to reach the sun's surface by convection, and will only be measurable, if at all, in a very distorted form. A. BEER

523.72 : 551.521.13

6421. Solar radiation and its measurement. K. WEGENER. *Geofis. pura appl.*, **22,** 205–36 (*April–June*, 1952) *In German.*

Discussion of the history and the results of 4½ years' observations in the Argentine, carried out to obtain temperature measurements on the sun based on application of the Boltzmann–Stefan and l laws. Previous radiation measurements are criti and an effect of the vertical exchange of air n on the radiation of the air between the sun ar instrument is studied; the view is expressed that measurements only give the difference betwee solar constant and the albedo of the atmosphere value of what the author considers as the true constant is estimated as 2·4. Criticisms of liminary statements of these results are replied t

A.

523.72 : 621.39

6422. The distribution of radio brightness ove solar disk at a wavelength of 21 centimetres. new highly directional aerial system. W. N. CH IANSEN AND J. A. WARBURTON. *Austral. J. Phys* 190–202 (*June*, 1953).

A new aerial system of very high resolving po has been designed for use in determining the di bution of radio brightness across the solar disk wavelength of 21 cm. Thirty-two aerials with p boloidal reflectors are evenly spaced in an east- direction over a distance of about 700 ft, and connected by a branching system of balanced op wire transmission lines to a receiver. The ae system produces multiple beams each 3′ of arc w and spaced 1·7° apart. The rotation of the ea causes one after another of the aerial beams to s the disk of the sun. The record obtained from radio receiver gives a one-dimensional brightn distribution over the solar disk.

523.

6423. The limb-darkening of the Sun at the rad frequency of λ10·7 cm. M. WALDMEIER. *Z. Astr phys.*, **32,** *No.* 2, 116–24 (1953) *In German.*

This radiation appears to originate from coron condensations above sunspot groups of the type Its intensity decreases with increasing distance of t group from the centre of the sun: at the limb it t only 22% of its central value. This strong lim darkening effect cannot adequately be accounted f by absorption. An explanation is suggested, base on particular structural details of the condensation e.g. on the assumption of an ellipsoidal shape with th three semi-axes 0·153, 0·076 and 0·069 solar radii.

A. BEE

523.7

6424. Distribution of radiation flux across a sunspo A. K. DAS AND A. S. RAMANATHAN. *Z. Astrophys.* **32,** *No.* 2, 91–103 (1953).

Intensity variation curves for a large sunspot unde very good observing conditions have been obtaine for discrete wavelengths in the continuous spectrum in the 4000 Å region. The intensity ratio spot/photo sphere is found to decrease with decreasing wave length varying from 38% to 34% in the region unde consideration. Another fairly large spot photo graphed earlier is found to give about the same valu in the continuous spectrum. Intensity variation curves along selected absorption lines in the same region have also been obtained for the same spot from these curves a quantitative estimate of the decrease of contrast between the spot and the back ground with increase of height above the photosphere is obtained. The intensity of the bright ring around

he penumbra has been measured. It is found to be about 2% to 3% greater than that of the background at the lowest level, but increases at higher levels. The brightness of Secchi's bright ring around the umbra has also been estimated; it does not appear to vary with height in the same way as the outer ring. The investigation is being continued. A.

523.746 : 550.38

6425. On the control of geomagnetic activity by sunspots. J.-F. DENISSE. *C.R. Acad. Sci.* [*Paris*] **236,** 1856–8 (*May* 11, 1953) *In French.*

An analysis of geomagnetic activity accompanying the passage of spots across the solar disk leads to a division of sunspots into two types: *R*, whose passage is accompanied by a breaking-out of magnetic activity, and *Q*, accompanied by a diminution of activity. It is suggested that geomagnetic activity between storms is due to a flux of corpuscular radiation by evaporation from the solar corona which is enhanced by the presence of *R*-type spots and reduced or deviated by *Q*-type spots. It is further shown that of the *Q*-type spots, those with the greatest magnetic moment give the least delay of diminution of activity after central meridian passage; the greater the magnetic moment of the spot the greater the velocity of the particles which can be retained by the spot.

M. W. OVENDEN

523.755

6426. On the rotation of the inner corona. R. MÜLLER. *Z. Astrophys.*, **32,** *No.* 2, 104–15 (1953) *In German.*

The rotation is deduced from similarities and repetitions of the monochromatic corona in the light of λ5303 Å. It appears that the empirical law of the actual solar rotation, i.e. the decrease of the angular velocity from the equator towards the poles, cannot be applied to the inner corona: for the latter a mean angular velocity of 14°·11 per day is arrived at, valid for all latitude zones; this is the same value as that for sunspots at ±18° latitude. It is concluded that the inner corona does not participate in the solar rotation. A. BEER

523.755 : 550.385

Correlation of magnetic M-storms with the monochromatic corona. *See Abstr.* 7340

523.77

6427. Intensity of Lyman-alpha line in the solar spectrum. W. A. RENSE. *Phys. Rev.*, **91,** 299–302 (*July* 15, 1953).

The Lyman-alpha line appeared on a rocket spectrogram recently obtained by a group at the Physics Department of the University of Colorado. The grazing-incident spectrograph had been pointed directly at the sun during the 28 sec exposure by a biaxial sun-follower in an Aerobee rocket. The average altitude during exposure was 81 km. Lyman-alpha was the only line observed in the far ultraviolet. It is about 5 angstroms broad and exhibits, for the altitude range of the rocket during the exposure, a narrow emission centre with broad emission wings. The total intensity outside the earth's atmosphere is estimated to be 0·05 microwatt/cm². Instrumental scattering could have masked the light of any faint far-ultraviolet continuum which may have penetrated to the atmospheric levels reached by the rocket during the exposure. A.

523.77 : 523.87

6428. On the problem of the appearance of oxygen lines in the spectrum of the sun and of certain stars. A. A. NIKITIN. *Dokl. Akad. Nauk SSSR,* **84,** *No.* 5, 913–15 (1952) *In Russian.*

Lines identified as due to oxygen atoms have previously been found in radiation from the corona and disk of the sun and from certain stars. This paper is an attempt to ascribe some of these lines to transitions with changes in the main quantum number. Widths of lines are calculated assuming that excitation and ionization of oxygen occur in the upper atmosphere of the sun; these are compared with observed widths where available. E. RABKIN

523.774

6429. Determination of the surface temperature of the sun through a study of the intensity of vanadium lines. H. VAN REGEMORTER. *C.R. Acad. Sci.* [*Paris*] **236,** 1536–8 (*April* 20, 1953) *In French.*

A previously published method for the determination of a model stellar atmosphere [Abstr. 6259 (1952)] is applied to the case of the sun. The use of VI leads to 4151° ± 30°, a value which is, as it should be, considerably smaller than the observational data available for solar effective temperatures (Abbot, Nicolet; mean ~5740°) and also smaller than those for the excitation temperatures (Menzel, Wright, King, Hunnaerts; mean ~4540°). It is also smaller than the surface temperature values derived by Barbier, Chalonge and Kourganoff, and Peyturaux, but agrees with that obtained for hydrogen by de Jager (1952). A. BEER

523.821.5 : 537.312.5 : 621.383

6430. Photoelectric stellar photometry using an E.M.I. photomultiplier. A. N. ARGUE. *Proc. Roy. Irish Acad. A,* **55,** *No.* 8, 117–32 (*Feb.*, 1953).

The performance of a new type of photomultiplier of improved design is described. The cathode is of the Sb–Cs type, circular in shape about 1 cm in diameter. The multiplier has 11 stages, each dynode being arranged in a Venetian blind fashion. Full details are given of the installation and use when attached to the South 12 in. refractor at Dunsink Observatory. Lists on *Ao* type stars down to 10th magnitude were made for determinations of both magnitude and colour index, and comparisons with other results are given. Several suggestions for further improvements including refrigeration of the tube are made which should lead to increased sensitivity. E. G. MARTIN

523.83

6431. Physical and spatial characteristics of stars with $V \geqslant 40$ km/sec. Longitudinal effect for a group of stellar velocities. M. C. BALLARIO. *R.C. Accad. Naz. Lincei,* **14,** 251–5 (*Feb.*, 1953) *In Italian.*

Previous investigations of the motions of stars of apparent magnitude $\geqslant 5{\cdot}5$ are extended to include higher velocity groups. Special attention is given to the existence of preferred directions of motion and to the variation of mean velocity with longitude.

R. A. NEWING

523.83

6432. The point of maximum frequency in the distribution of proper motions of stars nearer than 20 parsecs. J. DELHAYE. *C.R. Acad. Sci.* [*Paris*] **236**, 1471–2 (*April* 13, 1953) *In French.*

Following Stromberg's work on solar motion, and on the elements of the ellipsoid of velocities for stars distant < 20 parsecs, the analysis is extended to obtain equi-density charts showing points of max. frequency for stars of spectral types, A, F, G, K and M. A single maximum is found for type A stars, close to the theoretical centre of the star-cloud defined by classical solar motion. For the other spectral types this centre does not correspond to a point of frequency maximum. D. R. BARBER

523.84

6433. The law of association by magnitudes of the components in double stars. P. MULLER. *C.R. Acad. Sci.* [*Paris*] **236**, 1331–3 (*March* 30, 1953) *In French.*

Using homogeneous observational material for more than 300 double or multiple stars down to between 9 and 10 mag., comparison is made of the observed numbers of stars within ten equal magnitude intervals (Δm, 0·2 mag.) with those computed on the assumption of a random association of stellar pairs. The basic equation is: $\log N(\Delta m) = a - b \cdot \Delta m$, where the constant, b, is given the same value as that applicable to the observed distribution of simple stars down to 8 mag.; and a is a constant dependent on the total material available. The departure of observed from calculated value in each mag. range falls within the expected statistical fluctuation, and the correlation of $N_{obs.}$ with $N_{calc.}$ is found to be significant. Thus it is concluded that the visual double-stars, when examined on the basis of magnitude only, represent a purely fortuitous grouping of stellar pairs. D. R. BARBER

523.842

6434. The density of stars of different spectral types. E. A. KREIKEN. *Z. Astrophys.*, **32**, *No.* 2, 125–32 (1953).

According to a previous article [Abstr. 1348 (1953)] the period of binary systems is given by the relation $\log P = -0{\cdot}542 \log \rho_{min} - 0{\cdot}301$. Consequently the distribution of the periods of the binaries simultaneously must represent the distribution of the densities of the teneous components. For those eclipsing variables for which the spectral type of the teneous components is known, the distribution of these densities is investigated and compared with that of the Cepheids. With the eclipsing stars both the main sequence and the giant series are clearly indicated. The region occupied by the eclipsing stars is avoided by the Cepheids and conversely. The interval which separates the long and the short period Cepheids coincides with the region where the Cepheid belt intersects the giant series. A.

523.852

6435. New system of fine-fibrous nebulae in Auriga. G. A. SHAĬN and V. F. GAZE. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 53–4 (1952) *In Russian.*

Seven photographs by Hα radiation have been taken, during 3 months of 1952, of a wispy nebulosity in Auriga fairly near BOe (BD + 26·883°), and somewhat farther away from two other BOe s (BD + 27·797°, BD 27·798°). A variability of new feature suggests that it may represent star-tra in a field of force. Various possible origins for illumination of the nebulosity are examined, includ light from Nova Aurigae 1891, but none are c sidered really satisfactory. R. C. MUR

523.877 : 52

6436. Carbon stars, comets and combustion phe mena. B. ROSEN AND P. SWINGS. *Ann. Astroph* **16**, *No.* 2, 82–95 (1953).

The emitter of the 4050 Å group in comet-h spectra is discussed in relation to its occurrence late *N*-type stars, comets, flames, discharges a photolysis. The emitter is probably C_3 and a p visional vibrational analysis is given. Bands at 37 and 4352 may belong to the system. The group always associated with the formation of soot particl It may be associated with carbon particles in t atmospheres of stars and with proton bombardme of carbon or organic ices in comets. A. G. GAYDO

523.877 : 539.155

6437. The abundances of the elements. E. M BURBIDGE AND G. R. BURBIDGE. *Observatory*, 7 69–74 (*April*, 1953).

A short report of some of the papers read at t conference held at Yerkes Observatory, in Novembe 1952. The following are summarized: *Theoretic methods for the analysis of stellar atmospheres*, B Strömgren. *Review of present observational data o stellar abundances*, G. P. Kuiper. *On the differenc in chemical composition between high- and low-velocit stars*, R. Wildt [see Abstr. 3246 (1952)]. *Difference in abundances between the atmospheres of stars of typ C, M and S*, P. C. Keenan. *Anomalous abundance in cooler stars*, W. P. Bidelman. *Discussion of som new results on H-poor, C-rich stars*, G. H. Herbig *Abundances in the Wolf–Rayet stars*, P. Swings. *Th hydrogen-helium ratio*, A. B. Underhill. *Review o stellar isotopic abundances*, A. McKellar. *Convection zones and compositions in stellar interiors*, B. Strömgren *Theoretical aspects of stellar evolution*, M. Schwarz schild. *Abundances in the primary cosmic rays* S. F. Singer. *The origin of the elements*, M. G Mayer [see Abstr. 1938 (1950)]. *Ylem theory of the origin of atomic species*, G. Gamow [see Abstr. 6951 (1950)]. *Initial conditions for a non-equilibrium theory of element formation*, R. A. Alpher.

523.877 : 539.17

6438. On certain nuclear reactions of astrophysical importance. IV. Sensitivity of thermonuclear reactions. E. SCHATZMAN. *Ann. Astrophys.*, **16**, *No.* 3, 162–78 (1953) *In French.*

For previous parts see Abstr. 5475 (1950), 6716–7 (1951). The dependence of the rate of energy production on density and temperature is investigated for the following reaction chains: (1*a*) $H^1 + H^1 \rightarrow H^2 + e^+$, $H^2 + H^1 \rightarrow He^3$, (1*b*), $He^3 + He^3 \rightarrow He^4 + H^1 + H^1$; (2) $He^3 + e^- \rightarrow H^3$, $H^3 + H^1 \rightarrow He^4$ preceded by (1*a*); (3) $H^1 + e^- \rightarrow n$, $n + H^1 \rightarrow H^2$ followed by (2); (4) $He^4 + He^4 \rightleftharpoons Be^8$, $Be^8 + He^4 \rightarrow C^{12}$, $C^{12} + He^4 \rightarrow O^{16}$. Applications to problems of stellar vibrational stability are suggested. R. A. NEWING

526.1

6439. On a calculation to a further approximation of the deviation of the geodesic from a normal section on any surface. M. Mineo. *R.C. Accad. Naz. Lincei*, **14**, 255–9 (*Feb.*, 1953) *In Italian.*

Calculates to terms of 3rd order the angle between a geodesic and a normal section passing through the same two points on the surface. Geodetic applications, to arcs 1000 km long, are mentioned.

A. H. COOK

PHYSICS 53

53 : 62 : 51

Advanced mathematics in physics and engineering. *See Abstr.* 6372

53.081.5

6440. The dimensions of physical quantities. R. Fürth. *Brit. J. appl. Phys.*, **4**, 201–3 (*July*, 1953).

Summary of the addresses and discussion at the Institute of Physics, London, 18 March, 1953.

53.082 : 530.162

6441. The Brownian motion of electrometers. J. M. W. Milatz and J. J. van Zolingen. *Physica*, **19**, 181–94 (*March*, 1953).

The equation of motion of an electrometer appears to be of the 3rd order. For sufficient high labilization, critical damping occurs at two values of the resistance R of the measuring circuit. The Brownian motion accounts for the greatest part of the irregular molecular collisions of the surrounding air, the thermal voltage fluctuations contributing only very slightly. From the expression $\overline{\Delta Q^2} = 2kT\tau/R + 2kT(AC_0 + B^2)C_0/B^2$ it follows that for a Hoffmann electrometer the root mean square error in charge measurements caused by the molecular collisions appears to be seventy times larger than the error arising from the thermal voltage fluctuations. Both the fluctuating torque exerted by the molecular collisions and the air damping are aspects of the interaction of the instrument with the surrounding air. Air damping not being essential for the proper working of the electrometer, the Brownian motion may be reduced substantially by evacuating the instrument and applying an artificial damping which introduces almost no fluctuations. A.

53.082 : 530.162

6442. The reduction in the Brownian motion of electrometers. J. M. W. Milatz, J. J. Van Zolingen and B. B. Van Iperen. *Physica*, **19**, 195–207 (*March*, 1953).

This is achieved by replacing the air damping by a special type of artificial damping, realized by means of a photoelectric amplifier containing a differentiating circuit. The amount of light entering the photocell is made proportional to the deflection of the electrometer system and the output of the amplifier is fed back to the electrometer. The motion of the electrometer is studied with a photoelectric relay and a recording galvanometer allowing a magnification up to 14 300×. The application of this method of damping has already resulted in a hundred fold reduction of the Brownian energy and an increase in precision of a factor of ten. To reach the same accuracy with normal air-damping it would be necessary to cool the instrument to 3°K. A.

53.082 : 550.34

6443. The influence of microseismic perturbations on a cold damped electrometer. J. M. W. Milatz and A. H. Wapstra. *Physica*, **19**, 166–74 (*March*, 1953).

It is proved that the excess fluctuation of an electrometer above the electrical and mechanical Brownian movements found in a former investigation [Abstr. 6442 (1953)] was due to microseismic movements of the soil. A theory is developed of the influence of mechanical perturbations on a cold damped electrometer. This theory predicts a characteristic connection between the course of the excess fluctuation with the damping and the Fourier spectrum of the microseismic movement; this connection was checked experimentally. A further proof is the fact that the Fourier spectrum of the microseismic movement deduced from the spectrum of a recording of the fluctuation of the electrometer is in agreement with a Fourier analysis of a seismogram. A.

FUNDAMENTALS 530.1

530.12

6444. The divergence identities in [Einstein's] new unified theory. S. N. Bose. *C.R. Acad. Sci.* [*Paris*] **236**, 1333–5 (*March* 30, 1953) *In French.*

Results obtained by contraction of Bianchi identities [Abstr. 4075 (1951)] are here obtained by a variational method due to Hilbert. R. A. NEWING

530.12

6445. Mass-energy relationship. J. Riseman and I. G. Young. Letter in *J. Opt. Soc. Amer.*, **43**, 618–19 (*July*, 1953).

Note on "Mass-energy relationship" by J. Riseman and I. G. Young. H. E. Ives. *Ibid.*, 619.

It is shown that Ives' discussion [Abstr. 7020 (1952)], when supplemented by dimensional considerations, leads to Einstein's relation. Ives reiterates his claim that Einstein's 1905 derivation involves unwarranted assumptions. R. A. NEWING

530.12 : 538.3

6446. Electromagnetism and gravitation. N. S. Kalitsin. *Izv. Bulg. Akad. Nauk*, **2**, 49–60 (1951) *In Bulgarian.*

Electromagnetic and gravitational fields are united in a 5-dimensional Euclidean space of 4 real and 1 imaginary dimension according to Nordstroem's suggestion (1914). Let R_5 $(x_1, x_2, x_3, x_4, x_5)$ be the 5-dimensional space-time continuum, $R_4(x_1, x_2, x_3, x_4)$, where $x_4 = ict$, the 4-dimensional continuum. In R_5 there are particles ω, in R_4 counter-particles ω, all moving along world-trajectories in R_5. The charge of the ω-particles is ε, that of the ω-particles $-\varepsilon$. The charge density in the space (x_1, x_2, x_3, x_5) is ρ. The elementary particles, viz. electrons, positrons, photons, mesons, protons, neutrons, etc., are regarded as

straight current filaments of constant sections at right angles to the 3-dimensional world $R_3(x_1, x_2, x_3)$ and extending along x_5 from $-\infty$ to $+\infty$. In these filaments the ω and ϖ particles flow. An electrically charged particle represents a filament in which ω or ϖ particles flow only in one direction, whereas a neutral particle consists of 2 filaments in one of which flow ω, and in the other ϖ particles, in opposite directions. The last 2 conditions become redundant if bodies of negative mass and kinetic energy are introduced. It also follows that all field parameters are independent of x_5. The theory presented yields the electromagnetic and gravitational interaction between elementary particle-current filaments.

B. F. KRAUS

530.12 : 538.3

6447. A generalization of the equations of electrodynamics. N. S. KALITSIN. *Izv. Bulg. Akad. Nauk*, **2**, 63–76 (1951) *In Bulgarian.*

The theory presented is based on a 6-dimensional Euclidean space of 5 real and one imaginary dimension x_4, although the formulae derived hold for an Euclidean space of an arbitrary number of dimensions. The author suggests the substitution of an antisymmetrical tensor of rank 2 in this 6-dimensional Euclidean space for the electromagnetic potential in the 4-dimensional Minkowski world, in order to get a unified electromagnetic-gravitational field. The invariance and contravariance relations of the field tensors are derived and the equations obtained, interpreted in the 4-dimensional Minkowski world (by assuming all the field parameters to be independent of x_5 and x_6), define what the author calls the electromagnetic gravitation "bi-field" of an elementary particle with its quasi-electric, quasi-magnetic and quasi-gravitational moments. B. F. KRAUS

530.12 : 538.3

6448. Unified field theory in the 6-dimensional space. R. ZAĬKOV. *Izv. Bulg. Akad. Nauk*, **2**, 79–94 (1951) *In Bulgarian.*

Author presents an improved version of N. S. Kalitsin's generalized electrodynamics (preceding abstract), after a demonstration that the latter author failed to find the key-relation existing between the components of the anti-symmetrical tensor $I_{\alpha\beta}$ generalizing the electric 4-current vector I_i in the 6-dimensional space and the components of the 6-vector W_α of the velocity. That is why Kalitsin obtained Newton's theory of gravitation instead of Einstein's, and did not obtain really generalized equations of motion of elementary particles. The present author, however, succeeded in finding the monovalent functional relation between $I_{\alpha\beta}$ and W_α. This yields the unified equations of motion of particles, closely interlinking gravitation and electromagnetism. Furthermore, a new field described by the vectors $\vec{\psi}\ \vec{\Omega}$ was obtained, which is related to the spin properties of matter. The gravitational field is given by the components of a 4-vector (g, g_0) and by a scalar. This results in a sufficient number of disposable constants of integration being available for adjusting the theory of gravitation to observations. The three effects of the general theory of relativity could so be derived, Einstein's value 1·7465" for the deviation of a ray of light grazing the sun being improved to 2·2417" (agreeing with Freundlich's experimen value 2·24 ± 0·10"). B. F. KRA

530.1

6449. Mathematical aspects of the quantum theo of fields. V. Fields modified by linear homogenec forces. K. O. FRIEDRICHS. *Commun. pure ap Math.*, **6**, 1–72 (*Feb.*, 1953).

For Pt IV, see Abstr. 2183 (1953). The proble of a boson field ϕ under the action of a source dist bution linear and homogeneous in ϕ (e.g. the effe of an external e.m. field) is solved when the dist bution satisfies appropriate smoothness condition A number of forms are found for the unitary operat relating the modified particle representation to th unmodified particle representation and their relatio ships are investigated. The transition probabili for a finite time interval is obtained explicitly an also its limit over infinite interval. This problem considered also for a fermion field but can be solve by these methods only for special cases (e.g. externa electrostatic field). R. H. DALIT

530.14

6450. The significance of the quantum of action J. FUCHS. *Elektrotech. u. Maschinenbau* [*EuM*] **70** 77–87 (*Feb.* 15, 1953) *In German.*

It is shown that the Planck quantum of action h can be expressed in a physically significant form as a function of the electric and magnetic properties of the elementary charge and of the vacuum in the form $h = \frac{1}{2}e^2 137(\mu_0/\varepsilon_0)^{\frac{1}{2}}$. The substitution of h in various atomic and nuclear equations shows (with precautions relating to the velocity of light c and the classical electron radius r_0) that the quantum of action can be eliminated therefrom, without a hitherto unknown constant needing to take its place. The equations thus derived show heuristically valuable forms of new physical significance. They support the conception that the existence of the quantity h is one of the results of the finite value of the elementary charge and not its cause.

[The above abstract replaces Abstr. 3854 (1953)]. A.

530.145

6451. A reply to the argument directed by Einstein, Podolsky and Rosen [1935] against Bohr's interpretation of quantum phenomena. O. COSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] **236**, 1632–4 (*April* 27, 1953) *In French.*

A paradox, arising when measurements carried out on one particle are used to derive information concerning a second particle and originally stated in terms of action at a distance, is here restated in terms of retrospective causality. It is maintained that the paradox provides no valid argument against quantum-mechanical principles of measurement. R. A. NEWING

530.145

6452. On the interpretation of quantum mechanics with the aid of hidden variables in the sense of David Bohm. R. DUGAS. *Rev. sci.* [*Paris*] **90**, 261–4 (*July–Aug.*, 1952) *In French.*

A critical survey of Bohm's interpretation of quantum mechanics and its relation to the views of Herz in classical theory, of von Neumann in quantum theory and of de Broglie in the pilot-wave theory.

R. H. DALITZ

530.145

6453. On the density matrix in Hartree–Field. H. Itô. *Progr. theor. Phys.*, **7**, 406–16 (*April*, 1952).

The density matrix of a many-particle system is examined in the light of the theory of symmetric groups and is brought to reduced forms for convenient practical manipulations. The density matrix of a many-electron system is computed eliminating spin variables. In this case a version of the theorem of large numbers is applied to the total spin quantum number. A.

530.145

6454. Boundary conditions in the mechanics of fields. S. M. Neamtan and E. Vogt. *Canad. J. Phys.*, **30**, 684–98 (*Nov.*, 1952).

A variational principle has been set up for the description of relativistic fields with the aid of Lagrangians involving second order derivatives of the field functions. This constitutes a generalization of the usual formulation in that, besides the boundary conditions usually imposed, it admits also linear homogeneous boundary conditions. The formulation has been developed for the complex scalar and complex vector fields. The variational principle then yields not only the wave equations but also the allowed boundary conditions. A Hamiltonian and equations of motion in canonical form can be set up. A symmetric stress–energy tensor and a charge–current vector are defined, yielding the usual conservation equations. For the vector field, π_4 is not identically zero; also the Lorentz condition arises out of the variational principle and does not have to be separately imposed. For the Dirac field an extension to Lagrangians with second order derivatives is not possible, but for this field also the variational principle yields the allowed boundary conditions. A.

530.145

6455. Action principles for the field theory of matter. W. Scherrer. *Helv. phys. Acta*, **25**, *No.* 5, 501–4 (1952) *In German.*

The static central-symmetric solutions for a field ϕ_P given by an action principle generalizing that given earlier for a scalar field [Abstr. 1454 (1950)] are considered. In a certain range of the parameters, two solutions exist with finite energy-momentum integrals, and the energy and mass values to be associated with these solutions are discussed.

R. H. DALITZ

530.145 : 532.51 : 536.48

Quantum hydrodynamics and the theory of liquid helium. *See Abstr.* 6726

530.145 : 532.51 : 538.3 : 539.3

6456. Integral representation of the field vector. I. S. Arzhanykh. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 55–8 (1952) *In Russian.*

Mathematical. A formula is developed of the type of Green's formula for boundary problems. The solution of those problems of hydrodynamics, elasticity and electrodynamics is sought which is connected with differential equations of classical field-theory. J. JACOBS

530.145 : 538.3

6457. Determination of the potentials in generalized electromagnetic fields. E. Storchi. *R.C. Accad. Naz. Lincei*, **14**, 261–7 (*Feb.*, 1953) *In Italian.*

Finzi [Abstr. 2175, 2966 (1953)] has introduced generalized fields of which the electromagnetic and the meson fields are special cases. It is proved in the present paper that the equations of the general case can always be separated into equations corresponding to the two particular fields, except in a singular case in which the determination of the potentials depends on the linear combination of the two particular potentials. L. PINCHERLE

530.145

6458. Remarks on scalar pair theory. G. Wentzel. *Helv. phys. Acta*, **25**, *No.* 5, 569–76 (1952) *In German.*

This theory [Abstr. 87, 3326 (1951)] is extended to take account of the exclusion principle by using a Fermi gas of nucleons instead of a fixed lattice. A discussion of the potential energy (expanded to the 3rd power in the coupling) suggests that 3- and more-body forces are responsible for saturation and that exchange forces play a subsidiary role.

W. J. SWIATECKI

530.145

6459. Contribution to the study of methods of second quantization and of configuration space in the relativistic theory of systems of particles: application to the derivation of relativistic equations for the deuteron. I. General formalism of the passage from second quantization to configuration space. II. Deduction of relativistic equations, in configuration space, for a system of two fermions interacting through the medium of a neutral boson field of spin zero. M. Jean. *Ann. Phys.* [*Paris*] **8**, 338–91 (*May–June*, 1953) *In French.*

An expanded treatment of results already reported [see Abstr. 5086, 7519 (1951) and 66–7 (1952)].

530.145 : 538.565 : 621.396.611

6460. Quantum theory of a damped electrical oscillator and noise. J. Weber. *Phys. Rev.*, **90**, 977–82 (*June* 1, 1953).

Field quantization is applied to an electrical oscillating circuit. Damping effects are treated by perturbation theory. Quantum effects occur both in the damping and in the noise, and are discussed in detail. An interpretation is given of the infinite zero point contribution which appears in the theory of Callen and Welton. The average electromagnetic field energy of an oscillator with capacitance C, conductance G, and natural frequency ω as a function of time is given by $U = (\frac{1}{2}\hbar\omega + W)(1 - e^{-Gt/c}) + U_0 e^{-Gt/c}$ where $W = \hbar\omega[\exp(\hbar\omega/kT) - 1]$. The mean squared noise voltage which would be measured in an experiment with a damped oscillator is given by $\overline{V^2} = C^{-1}(\frac{1}{2}\hbar\omega + W)$. The maximum noise power which a conductance G at temperature T can transfer to a damped oscillator approaches the value GW/C. The vacuum fluctuations are shown to be observable in certain noise experiments. A.

530.145

6461. Gauge transformations in electrodynamics. P. A. M. Dirac. *Ann. Inst. Poincaré*, **13**, *No.* 1, 1–42 (1952) *In French.*

An exposition of the author's development of a Hamiltonian formulation for an e.m. theory allowing

gauge transformations (i.e. without Lorentz condition). Its application to the quantization of the e.m. field in vacuum, in interaction with a Pauli–Weisskopf field, or in interaction with spinning electrons is discussed. R. H. DALITZ

530.145

6462. Quantum field theory of bound states. III. Bound states in strong interaction. R. J. EDEN AND G. RICKAYZEN. *Proc. Roy. Soc. A*, **219**, 109–19 (*Aug.* 11, 1953).

For Pt II, see Abstr. 4597 (1953). The conditions for applying a strong interaction approximation to an electron-proton propagator are obtained. It is shown that when the total energy is sufficiently great the bound-state part of the propagator can be neglected and only the scattering approximation need be considered. The strong interaction approximation is used for relativistic calculations of the following interactions involving the hydrogen atom: coherent scattering of light; photo-electric emission; electron scattering involving exchange. These calculations differ from those of earlier theories by representing the hydrogen atom as a two-particle system in interaction, instead of an electron and a fixed nucleus. It is shown how the two-particle formalism goes over to the usual theory when the proton mass tends to infinity. A.

530.145

6463. General theory of damping phenomena for non-stationary processes. II. Separation of the virtual states. Second order corrections. E. ARNOUS AND K. BLEULER. *Helv. phys. Acta*, **25**, *No.* 5, 581–98 (1952) *In German.*

For Pt I, see Abstr. 9272 (1951). General expressstions for the radiative corrections to the form and breadth of an emission line are obtained here by use of a canonical transformation eliminating the virtual processes. This transformation introduces a "finite energy shell" whose extension is related to the exciting spectrum, and some of the corrections depend explicitly on the excitation conditions. The e^2 corrections to the classical line shape are worked out, and the displacement of the line maximum is shown to be given to high accuracy by the level shifts ($\simeq$ self energies) as usually calculated, which are independent of excitation conditions. R. H. DALITZ

530.145

6464. General theory of damping phenomena for non-stationary processes. III. e^4 corrections to the line breadth. E. ARNOUS. *Helv. phys. Acta*, **25**, *No.* 6, 631–52 (1952) *In German.*

The e^4 correction to the line breadth is written in a covariant form (excepting a part depending on the excitation conditions) and is shown to be finite and unambiguous. In non-relativistic approximation, it is $\sim\gamma/137^3 - \gamma^2/\pi\varepsilon$, where γ is the line breadth in 2nd approximation and 2ε is a measure of the extension of the incident exciting spectrum. R. H. DALITZ

530.145

6465. The angular momentum of multipole radiation. C. M. DE WITT AND J. H. D. JENSEN. *Z. Naturforsch.*, **8a**, 267–70 (*April*, 1953) *In German.*

In the classical theory a multipole of order (L, M) and frequency ω radiates angular momentum. The total angular momentum $\mathfrak{L}$ emitted in unit time i the direction of the polar axis, and its squarec related to the square of the energy W emitted in u time by $\mathfrak{L}^2 : W^2 = M^2 : \omega^2$. According to quant theory the relation, for a single quantum of radiatio is $\mathfrak{L}^2 : W^2 = L(L+1) : \omega^2$. It is shown that th results are in agreement with the correspondenc principle. P. M. DAVIDSO

530.1

6466. Matrix elements in radiative transitio R. J. BLIN-STOYLE. *Proc. Phys. Soc.* [*London*] **66**, 729–32 (*Aug.*, 1953).

The matrix elements occurring in the theory radiative transitions of electrons and positrons for case of spherical symmetry are expanded in th general case as a series of radial integrals with know coefficients.

530.14

6467. Huyghens' principle and the diffraction of th electron in Dirac theory. E. DURAND. *C.R. Acad Sci.* [*Paris*] **236**, 1337–9 (*March* 30, 1953) *In French*

An expression is obtained expressing the Dira wave-functions at P in terms of their values on surface enclosing P, and its use in calculating electron diffraction effects is outlined. R. H. DALITZ

530.145

6468. A statistical model for the basic processes in the quantum theory of particles. F. BOPP. *Z. Naturforsch.*, **8a**, 228–33 (*April*, 1953) *In German.*

The basic processes in the quantum theory of particles can be described quantum-statistically and by correlation statistics. In the latter case one is concerned with the correlation between two (or three) time sequences with alternative characteristics.

R. H. DALITZ

530.145

6469. On the representation by spherical functions of solutions of the wave equations of particles with spin in constant potentials. Case of particles of spin $\hbar/2$ and $\hbar$. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **236**, 1750–3 (*May* 4, 1953) *In French.*

The angular dependence of solutions with quantized angular momentum are found in terms of spherical functions for particles of spin $\hbar/2$ and $\hbar$, in an external static potential, by a method which may be generalized for particles of arbitrary spin. R. H. DALITZ

530.145

6470. The interaction of elementary particles and the conservation laws. G. MARX. *Acta phys. Hungar.*, **3**, *No.* 1, 55–8 (1953) *In German.*

Following Wigner's idea [Abstr. 3747 (1950), 6288 (1952)] of the conservation of the nucleonic charge g carried by nucleons (and determining the strength of their interaction with mesons), the existence and conservation of a fermion charge ($f \simeq 2 \cdot 5 \times 10^{-12}$ cm$^{5/4}$ $g^{1/4}$ sec$^{1/2}$) is postulated to explain the well-known equality of the interaction constants in the three processes involving four fermions, viz. neutron decay, μ-meson decay and μ-meson capture. Like the conservation of electric charge, the conservation laws concerning g and f should be consequences of the correct field equations.

W. A. HEPNER

530.145

6471. Remarks on non-linear mesodynamics. D. IVANENKO, D. KURDGELAIDZE AND S. LARIN. *Dokl. Akad. Nauk SSSR*, **88,** *No.* 2, 245–7 (1953) *In Russian.*

Non-linear equations can be formulated in terms of quasi-dielectric constants depending on the field. The case $\Delta\Phi - k_0^2\Phi - \Lambda\Phi^3 = -4\pi g\rho$ is considered more closely. The parameter Λ can be estimated by equating the matrix element of e.g. the 4th order process of scattering of mesons on mesons through the intermediary of nucleons with the matrix element derived from the specific non-linearity $\sim\Phi^4$ in the Lagrangian. A similar value of Λ is obtained by inserting for ρ the relativistic Thomas–Fermi approximation $\sim\Phi^{3/2}[1 + (g\Phi/2Mc^2)]^{3/2}$. The solution of $\Phi'' + b\Phi^3 + c\Phi^2 + a\Phi + d = 0$ in elliptic functions is discussed. W. J. SWIATECKI

530.145

6472. Exchange forces in the causal interpretation. R. BASILE. *C.R. Acad. Sci.* [*Paris*] **236,** 1636–8 (*April* 27, 1953) *In French.*

Some considerations on the "quantum potential" for a system of two identical particles. R. H. DALITZ

530.145

6473. Exchange forces in causal theory. Limits of validity for the notion of exchange energy. R. BASILE. *C.R. Acad. Sci.* [*Paris*] **236,** 2488–9 (*June* 29, 1953) *In French.*

Following earlier work [preceding abstract] it is shown that an objective physical sense can be given to the notion of exchange energy only if the overlap of the zones of localization is small and the exchange energy is only a small correction to the Coulomb energy. R. H. DALITZ

530.145

6474. Variational methods in the theory of collisions. P. ROUSSOPOULOS. *C.R. Acad. Sci.* [*Paris*] **236,** 1858–60 (*May* 11, 1953) *In French.*

The variational principle by Kahan and Rideau [Abstr. 8674 (1952)] for a symmetric operator is generalized to the case of an arbitrary operator defined in Hilbert space. R. H. DALITZ

530.145

6475. On the multiple scattering of charged particles. R. MERTENS. *Meded. K. Vlaamse Acad. Wetensch.,* **15,** 1–16 (1953).

J. C. Mark's approximate method for neutrons (*Nat. Res. Council Canada, Reports MT*92, 97) is extended to the multiple scattering in a finite medium of charged particles (where the single-scattering law is strongly anisotropic). Starting with the transport equation the flux of particles is expanded in Legendre polynomials. An nth approximation is defined which leads to the integration of an ordinary differential equation of $2n$th order. The results are in agreement with Wang and Guth (1951). W. J. SWIATECKI

530.145 : 537.533.74 : 537.534.74

6476. On the multiple scattering of charged particles. R. MERTENS. *C.R. Acad. Sci.* [*Paris*] **236,** 1753–5 (*May* 4, 1953) *In French.*

A method of successive approximations for the solution of the integro-differential equation of multiple scattering with no ambiguity in the boundary conditions. The emerging current is in every approximation a positive definite, monotonically decreasing function of the deviation from the incident beam [contrast Wang and Guth, Abstr. 1864 (1952)]. W. J. SWIATECKI

530.145

6477. Exchange scattering in a three-body problem. H. E. MOSES. *Phys. Rev.*, **91,** 185–92 (*July* 1, 1953).

It is proved that in the three-body scattering problem, the prototype of which is the scattering of an electron by a hydrogen atom, the coefficient corresponding to exchange scattering behaves like a radially outgoing wave. The essential conjecture used by Mott and Massey in their treatment of the problem is thus verified. A.

530.145

6478. Three-body scattering problems. A. DALGARNO. *Phys. Rev.*, **91,** 198 (*July* 1, 1953).

Remarks on a paper by Borowitz and Friedman [Abstr. 2201 (1953)] on the exchange scattered amplitude in the Born approximation. W. A. HEPNER

530.145

6479. Matrix elements of spin-spin interaction. F. R. INNES. *Phys. Rev.*, **91,** 31–4 (*July* 1, 1953).

An expansion of the spin-spin interaction operator allows a derivation of matrix elements using the methods of Racah. Formulae are given for configurations involving two non-equivalent electrons and for n equivalent electrons. Extension of the results to other configurations may be made using known procedures. A.

530.145

6480. Noncentral force matrix elements for the nuclear d^2 configuration. L. W. LONGDON. Letter in *Phys. Rev.*, **90,** 1125 (*June* 15, 1953).

Summary of some matrix elements between two-nucleon states of the two-body tensor and spin-orbit interaction operators, using harmonic oscillator radial wave functions. W. A. HEPNER

530.145

6481. Divergence of perturbation theory. A. PETERMANN. *Arch. Sci.* [*Geneva*] **6,** *No.* 1, 5–23 (1953) *In French.*

The simple case of a scalar theory with zero rest-mass "photons" is investigated. Considering the Green's functions of this field theory, one obtains first a formula giving the exact Feynman graph number at the $2n$th approximation. This number is found to be asymptotically equal to $(n-1)!$ Further, a detailed analysis of the integrals appearing at the $2n$th approximation shows that the smaller of them gives a contribution greater than $(\text{const.})^n(\log n)^{-n}n^{-n/2}$. Then, the general term of the perturbation expansion is asymptotically $(\text{const.})^n(\log n)^{-n}n^{n/2}$ and shows its divergence. A.

530.145

6482. A new proof of the perturbation expansions in quantum mechanics. E. A. POWER. *Proc. Roy. Soc. A,* **218,** 384–91 (*June* 7, 1953).

The perturbation formulae of quantum mechanics are derived in the Schrödinger representation by elementary algebra. Their equivalence to those found in the interaction representation is demonstrated. A.

530.145

6483. On the interpretation of wave mechanics using waves with singular regions. L. DE BROGLIE. *C.R. Acad. Sci.* [*Paris*) **236,** 1453–5 (*April* 13, 1953) *In French.*

Defines more closely the form of the waves in the singular region in his double-solution theory, showing that the picture thus obtained is the natural consequence of the ideas which led to his discovery of wave-mechanics. R. H. DALITZ

530.145

6484. Numerical solution of the Schrödinger equation. A. V. MOHRENSTEIN. *Z. Phys.*, **134,** *No.* 4, 488–503 (1953) *In German.*

A development of Frost's method [Abstr. 2131 (1942)] applicable when an approximation to the many-dimensional solution is known, and the difference is corrected by trapezium-rule integrations of the quotient with a best choice of arguments based on the trial function. Application to the ground states of He and H_2 gives accuracies of $\pm 1{\cdot}4\%$ and $\pm 6{\cdot}5\%$ in the wave functions. W. J. SWIATECKI

530.145

6485. A WKB-type approximation to the Schrödinger equation. S. C. MILLER, JR AND R. H. GOOD, JR. *Phys. Rev.*, **91,** 174–9 (*July* 1, 1953).

The method closely resembles the usual WKB approximation. Whereas in the ordinary WKB method the exponential function is used as the basis of the approximation, in this paper the solutions of an arbitrary Schrödinger equation are used. The general advantage is that by proper choice of the arbitrary equation an improved approximation can be obtained. The method is illustrated by treating the potential well and potential barrier problems when there are two turning points. The approximations to the wave functions are continuous even across the turning points. The barrier transmission problem is treated uniformly for energies above and below the peak of the barrier. A.

530.145

6486. Reduction of relativistic two-particle wave equations to approximate forms. I. Z. V. CHRAPLYVY. *Phys. Rev.*, **91,** 388–91 (*July* 15, 1953).

An extension of the Foldy–Wouthuysen method to two-particle equations is developed. The relativistic Hamiltonian contains even-even, even-odd, odd-even, and odd-odd terms. To remove terms of the three latter types and thereby to convert the Hamiltonian into an even-even operator, canonical transformations are applied. A prescription for the proper choice of generating functions for such transformations is given, and an approximate expression (to the order c^{-2}) for the transformed Hamiltonian is obtained. The even-even character of the transformed Hamiltonian makes it possible to separate out the quadruple of equations for the four ψ-components describing both of the particles in positive energy states only. As an example the Breit equation is taken and its reduced form, obtained by the proposed procedure, is compared with its approximate form as obtained (by Breit himself) using the method of large components. A discussion leads to the result that the case $m_{\mathrm{I}} = m_{\mathrm{II}}$ is singular and requires a further development of the present scheme. A.

530.1

6487. On certain properties of potential barrie A. BLANC-LAPIERRE AND N. NIFONTOFF. *C.R. Acc Sci.* [*Paris*] **236,** 1634–6 (*April* 27, 1953) *In French.*

The matching of the wavefunctions in two mec separated by a potential barrier is defined by matrix M by analogy with four-terminals in circu theory. Some properties of M and methods application are discussed. L. PINCHER

530.14

6488. On the wave function of the annihilated photo S. SLANSKY. *C.R. Acad. Sci.* [*Paris*] **236,** 1860- (*May* 11, 1953) *In French.*

From the properties of an invariant deduced fro the photon wave function, it is considered that th annihilated state of the photon of the de Brogli theory must be localized in the region where th photon is capable of interaction with matter.

R. H. DALIT

530.145.6 : 530.16

6489. To every [form of] wave mechanics ther corresponds a [form of] statistical mechanics. T. D DONDER. *Bull. Acad. Roy. Belgique Cl. Sci.*, 38 *No.* 12, 1125–8 (1953) *In French.*

An extension of an earlier result (1941). The wave mechanical mean value of $F(q, p; t)$ is identical with the statistical mean value, if a suitably defined distribution function is introduced. E. H. SONDHEIMER

530.162

6490. Solution of the non-isotropic random flight problem in the k-dimensional space. C. C. GROSJEAN. *Physica*, **19,** 29–45 (*Jan.–Feb.*, 1953).

The solution of the generalized k-dimensional random flight problem is dealt with, where the paths are distributed according to given probability functions and where the scattering collisions are non-isotropic. A new method is introduced which is largely based on recurrence relations and therefore very different from the well-known procedure using discontinuous integrals. In the special case, when the collisions are isotropic and the paths have given lengths, the new results become identical to those originally obtained by the older method. A.

530.162

6491. Transition from the microcanonical to the canonical total by means of the δ-function. F. BOPP. *Z. Naturforsch.*, **8a,** 233–4 (*April*, 1953) *In German.*

The distribution function of a macrosystem consisting of N molecules is written down as an integral involving the Hamiltonian functions of the individual molecules. This integral is evaluated by using the Fourier expression for the δ-function. L. S. GODDARD

530.162 : 536.7

6492. The statistical mechanics of irreversible processes. I. G. KLEIN AND I. PRIGOGINE. *Physica*, **19,** 74–88 (*Jan.–Feb.*, 1953) *In French.*

The possibility is investigated of basing statistical mechanics of irreversible processes on the recurrence relations between the distribution functions of various orders (Yvon, Born–Green) and the superposition principle of Kirkwood. The case of a linear assembly, with interaction between nearest neighbours only, is studied in detail. It is shown that for this particular system the superposition principle is

gorously valid at equilibrium, and that it may also e used for a large class of non-equilibrium states. he equilibrium properties which are needed also or the study of non-equilibrium are examined. As result of the superposition principle, the recurrence elations are reduced here to a single equation for the istribution function of couples of neighbouring articles. The study of this equation for systems out f statistical equilibrium shows that besides the quilibrium solution, other stationary solutions exist. his fact is closely related, as shown in Pt II, to the ailure of the attempt to describe dissipative processes, ike thermal conduction, on the basis of recurrence elations and the superposition principle only, as it is he case in the theory of Born and Green. A.

530.162 : 536.7

6493. The statistical mechanics of irreversible processes. II. G. KLEIN AND I. PRIGOGINE. *Physica*, 19, 89–100 (*Jan.–Feb.*, 1953) *In French.*

The study of the statistical mechanics of irreversible processes in linear assemblies with nearest-neighbour interactions is continued. Some specific examples of perturbations (perturbation of the distribution of velocities and of the partition of the total energy between the kinetic and the potential energies) are studied in some detail. Although several interesting results can be deduced, it is shown that the Born–Green scheme, based only on the recurrence relations. and the superposition principle, cannot describe dissipative effects. This is particularly clear in the case of thermal conduction. In this case the inhomogeneous equation for the double distribution function is shown to have no stationary solutions, nor solutions which admit a mean value in time. The extension of this result to ordinary three dimensional systems is indicated. A.

530.162 : 536.7

6494. Generalized statistical mechanics and the Onsager relations. P. G. BERGMANN AND A. C. THOMSON. *Phys. Rev.*, **91**, 180–4 (*July* 1, 1953).

The Onsager relations assert certain symmetry relations for the cross coefficients that connect rates of flux in stationary non-equilibrium processes with the driving "thermodynamic forces." These relations are usually derived by an argument borrowed from fluctuation theory, with the assumption that the rate at which a fluctuation in an equilibrium ensemble regresses equals the rate at which the ensemble average of the same quantity will change in a non-equilibrium ensemble. In this paper fluctuation theory has been by-passed and similar symmetry relations have been derived for the corresponding cross coefficients in ensembles consisting of thermally isolated systems differing but slightly from an equilibrium canonical ensemble. For the case of large deviations from equilibrium, expressions for the same cross coefficients have been found which possess no symmetry properties but which are exactly the usual correlation coefficients of fluctuation theory. Because the present work is concerned with thermally isolated systems, stationary non-equilibrium processes cannot yet be described in a satisfactory manner. For the representation of such processes, one would need an ensemble of systems in which the intereaction with the surroundings is described in terms of additional random variables. A.

530.162 : 621.391

6495. Information theory. P. M. WOODWARD. *Brit. J. appl. Phys.*, **4**, 129–33 (*May*, 1953).

Introduces the early work of Hartley and the newer statistical theory developed by Shannon to readers unfamiliar with the subject. With the problem of storing information as a model, the information capacity of a physical system may be defined as the logarithm of the number of its distinguishable states. The information content of a message is then defined as the minimum capacity required to store it. These two definitions make it possible to appraise scientifically the efficiency of any storage system or communication channel; it is shown that the efficient use of a communication channel entails coding apparatus to match the statistical properties of the source to those which maximize the (mascroscopic) entropy of the channel. A.

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531.2

6496. Linear elastic stability. I. A critical analysis of methods. H. ZIEGLER. *Z. angew. Math. Phys.*, **4**, *No.* 2, 89–121 (1953).

The classification of all mechanical systems as conservative (gyroscopic or non-gyroscopic), or non-conservative (dissipative, circulatory or instationary), is used as a basis for discussing elastic stability. Bibliography. J. G. OLDROYD

531.2

6497. Examination of some integrals involving Bessel functions, which are of importance in elasticity theory. J. DÖRR. *Z. angew. Math. Phys.*, **4**, *No.* 2. 122–7 (1953) *In German.*

Integrals of the type $\int_0^\infty J_m^2(t)/(t+a)dt$ and $\int_0^\infty J_m^2(t)/(t+a)^2dt$, which arise in the theory of thick circular elastic plates, are reduced to finite integrals of Struve functions suitable for numerical integration. J. G. OLDROYD

531.259

6498. Deduction of the maximum torsional stress in a shaft with notches. S. MOMMA. Letter in *J. appl. Phys.*, **24**, 959–60 (*July*, 1953).

A description is given of the stress distribution in a twisted shaft with circumferential notches periodically along its length. J. G. OLDROYD

531.558 : 521.7

6499. Tables for rocket and comet orbits. S. HERRICK. *Appl. Math. Ser. Nat. Bur. Stand., No.* 20, 100 *pp.* (1953).

The tables are based on the formulae for rectilinear motion in the two-body problem, and consist of tables of $(1 - \cos E)$, $\sin E$ and E with argument $(E - \sin E)$ for the elliptical case, $\frac{1}{2}D^2$ and D with argument $\frac{1}{6}D^3$ for the parabolic case, and $(\cosh F - 1)$,

sinh F and F with argument (sinh $F - F$) for the hyperbolic case. It is shown how these tables facilitate the computations for non-rectilinear orbits with eccentricity near unity, such orbits being more closely related to the corresponding rectilinear orbit than to the parabolic one. It is pointed out that although the tables are designed for use with orbits whose eccentricities are near unity, they are actually usable for all values of eccentricity, including zero.

M. W. OVENDEN

MECHANICAL MEASUREMENTS 531.7

531.717.3 : 621.317.39 : 620.172.222

6500. Measurement by electrical resistance wire strain gauges. I. Wire strain gauges and accessories in general. C. ROHRBACH. *Arch. tech. Messen, Issue No.* 209 (*Ref.* J135–4) 139–42 (*June*, 1953) *In German.*

A survey of the properties required in the various components of wire strain gauges, of the construction of the flat wire grid itself, and of devices to protect the gauge from dampness.

G. WITTENBERG

531.752

6501. A vacuum microbalance for measuring sorption in dielectrics. A. G. DAY. *J. sci. Instrum.*, **30**, 260–3 (*Aug.*, 1953).

A balance for measuring the rate of sorption of water vapour by non-polar dielectrics is described. The beam assembly, which is constructed from hard glass, is contained in a vacuum tight brass case, and a fused quartz torsion fibre is used to measure the change in weight. An expression for the sensitivity of the balance is derived. With a load of 0·1 g a change of weight of 0·02 μg is indicated and a maximum change of 300 μg can be compensated by the torsion control.

A.

531.752

6502. Design and performance of a fused silica microbalance. H. CARMICHAEL. *Canad. J. Phys.*, **30**, 524–55 (*Sept.*, 1952).

The construction and the use of a robust microbalance with a fused silica beam are described. The design is such that the microbalance is undisturbed by convection even in surroundings where it would be impossible to use an ordinary microbalance; nevertheless, the instrument is very convenient to operate. A comprehensive theoretical treatment of the silica torsion balance and of the effects of constructi[illegible] imperfections is given and shown to be in good ag[illegible] ment with experiment. The performance is illustra[illegible] by means of an example where four samples of americium oxide, of masses between two and six micrograms, were weighed on 100 mgm, scale pans, with a proven accuracy better than 0·3%. The precautions that were taken to minimize the harmful effects of adsorption and dust are described. A commercial version of this microbalance is now available.

A.

531.752 : 621.389

6503. A high-speed electronic balance. A. JEUDON. *Ann. Télécomm.*, **8**, 190–6 (*June*, 1953) *In French.*

The weighing platform of this instrument is fitted to a spindle which also carries a soft iron [illegible] included in the magnetic circuit of two coils conn[illegible] in a 10 kc/s bridge. Movement of the iron [illegible] caused by loading the platform unbalances the br[illegible] A circuit including a detector, amplifier, p[illegible] corrector and coil located in a magnetic field and [illegible] to the main spindle makes the system self-balan[illegible] A speed of 50 weighings per sec is obtained[illegible] making use of a pass-band 300 c/s wide to rem[illegible] transients. The instrument has a range of 0–[illegible] and an accuracy of $\pm 0{\cdot}5$ g. Examples are give[illegible] applications to the weighing of letters and magn[illegible] articles.

G. HOW[illegible]

531.756 : 533[illegible]

6504. Remote measurement of density of a liquid variable surface level. S. KAWATA AND A. IT[illegible] *Rev. sci. Instrum.*, **24**, 473 (*June*, 1953).

An iron powder core I, an iron wire and a cylinde[illegible] are hung vertically from a spring which is fixed at [illegible] upper end. L is immersed in the liquid and I mo[illegible] freely within a fixed vertical coil which forms part [illegible] an oscillatory electronic circuit. A change of dens[illegible] of the liquid is converted into a change of buoyan[illegible] of L and resultant output current. A sketch of [illegible] apparatus, the electronic circuit and a test calibrati[illegible] of the instrument are given.

S. WEINTRO[illegible]

531.[illegible]

6505. On the measurement and recording of short ti[illegible] intervals. J. GROENEVELD. *Z. Phys.*, **134**, *No.* [illegible] 645–7 (1953) *In German.*

Bergmann's method [see Abstr. 7830 (1951)] f[illegible] the production of powder patterns is used. Arrang[illegible] ments for the measurement of a time of fall and f[illegible] the recording of a motion are described.

S. WEINTROU[illegible]

531.76 : 621.317.[illegible]

6506. The measurement of small intervals of tim[illegible] P. FAYOLLE. *Ann. Franç. Chronom.*, **7**, *No.* 1, 20–[illegible] (1953) *In French.*

An historical account of progress in the measure[illegible] ment of short time intervals (defined as those whic[illegible] are not measurable by ordinary chronometers[illegible] Measurements are made by comparison with [illegible] secondary standard of known period employing eithe[illegible] constant-speed film recording (electromechanica[illegible] chronographs) or special c.r.t. traces (linear, circula[illegible] spiral and television time bases). Electronic device[illegible] for multiplying and counting, leading to the ultra[illegible] chronograph, are also considered. Experimenta[illegible] [illegible] molecul[illegible] sec. [illegible] [illegible] [illegible]

531.767 : 623.54

6508. Measurement of the speed of projectiles. K. JACOBSEN. *Ingeniøren*, **62**, 311–16 (*April* 11, 1953) *In Danish.*

A description of the pendulum method, the Siemens spark chronograph, le Boulengé method, ballistic galvanometer, capacitor, and counter chronographs, and the grid, plate, coil, microphone and photocell impulse starters, and of a complete field installation with capacitor chronograph and photocell starter.

J. A. WILCKEN

531.787

6509. On the theory of the quartz fibre manometer. K.-D. MIELENZ AND E. SCHÖNHEIT. *Z. angew. Phys.*, **5**, *No.* 3, 90–4 (1953) *In German.*

An elementary, and a more rigorous, derivation of the damping of a single, and equally applicable to a double, quartz fibre (viscosity) gauge are given, leading to the same relationship $Ad/(pM^{\frac{1}{2}} + a)$ for the time for the maximum amplitude to decrease to half value, where d is the fibre thickness and p is the pressure of the gas of molecular mass M, but with different values for the constants A and a. In particular $A = 527$ and 112 for the two cases respectively and 121 for the original derivation of Haber and Kerschbaum [*Z. Elektrochem*, **20**, 296 (1914)]. As a test the characteristic of a double fibre gauge was determined experimentally for air. For $p = 10^{-5}$ to 5×10^{-2} torr the results agree with theory, but for higher pressures the experimental are less than the theoretical values. The experimental value of $A = 128$ and this is compared with the values for A for the single and double fibre gauges used by previous investigators. It is shown that A is always less for the single fibre instrument. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.121.13 : 541.182.4

The elastic and viscous properties of emulsions and suspensions. *See Abstr.* 7255

532.13

6510. A theory of the linear viscoelastic properties of dilute solutions of coiling polymers. P. E. ROUSE, JR. *J. chem. Phys.*, **21**, 1272–80 (*July*, 1953).

The necessary co-ordination of the motions of different parts of a polymer molecule is made the basis of a theory of the linear viscoelastic properties of dilute solutions of coiling polymers. This is accomplished by use of the concept of the submolecule, a portion of polymer chain long enough for the separation of its ends to approximate a Gaussian probability distribution. The configuration of a molecule is specified in terms of the vector which corresponds to its end-to-end separation. The configuration of a molecule which contains N submolecules is described by the corresponding set of N vectors. The action of a velocity gradient disturbs the distribution of configurations of the polymer molecules away from its equilibrium form, storing free energy in the system. The co-ordinated thermal motions of the segments cause the configurations to drift toward their equilibrium distribution. The co-ordination is taken into account by the mathematical requirement that motions of the atom which joins two submolecules change the configurations of both submolecules. By means of an orthogonal transformation of co-ordinates, the co-ordination of all the motions of the parts of a molecule is resolved into a series of modes. Each mode has a characteristic relaxation time. The theory produces equations by means of which the relaxation times, the components of the complex viscosity, and the components of the complex rigidity can be calculated from the steady flow viscosities of the solution and the solvent, the molecular weight and concentration of the polymer, and the absolute temperature. Limitations of the theory may arise from the exclusion from consideration of (1) very rapid relaxation processes involving segments shorter than the submolecule and (2) the obstruction of the motion of a segment by other segments with which it happens to be in contact. Another possible cause of disagreement between the theory and experimental data is the polydispersity of any actual polymer; this factor is important because the calculated relaxation times increase rapidly with increasing molecular weight. A.

532.13

6511. Difference in viscosity of *ortho*- and *para*-deuterium at low temperatures. E. W. BECKER, R. MISENTA AND O. STEHL. Letter in *Phys. Rev.*, **91**, 414 (*July* 15, 1953).

It has been suggested that the fact that *para*-H_2 has a greater viscosity than *ortho*-H_2 at low temperatures is connected with the absence of rotation in the ground state of *para*-H_2 and not with differences in symmetry [Abstr. 4633 (1953)]. This conclusion is now strengthened by measurements showing that *ortho*-D_2 (no rotation in the ground state) has a greater viscosity than *para*-D_2. No theoretical explanation has yet been given. R. O. DAVIES

532.137

6512. A new method for continuous viscosity measurement. General theory of the Ultra-Viscoson. W. ROTH AND S. R. RICH. *J. appl. Phys.*, **24**, 940–50 (*July*, 1953).

A new continuous ultrasonic viscometer employing a pulsed resonant exponentially damped magnetostrictive strip is described and treated theoretically. Properties of viscoelastic materials affecting the propagation of transverse elastic waves are derived and are related to the response of the viscometer. Typical applications of the use of the ultrasonic viscometer are presented. A.

532.14 : 531.756

Remote measurement of density of a liquid variable surface level. *See Abstr.* 6504

532.51

6513. Method of practical solution of problems of non-permanent filtration flows with a free surface. G. SCHNEEBELI AND P. HUARD DE LA MARRE. *C.R. Acad. Sci.* [*Paris*] **236**, 1327–9 (*March* 30, 1953) *In French.*

Two practical methods, viz. that of the rheoelectric network and that utilizing conducting paper [Abstr. 648 (1953)] for solving the filtration equation, given in the form $\overline{V} = -k \operatorname{grad} \phi$, where $\phi = p/\omega + z$ (the z axis being directed vertically upwards), are very briefly referred to. The result relating to the

drainage of a rectangular plot, derived by the method utilizing an electrical network, is given by way of illustration. J. S. G. THOMAS

532.51 : 530.145 : 536.48

Quantum hydrodynamics and the theory of liquid helium. *See Abstr.* 6726

532.51 : 534.222.2

6514. Method for the determination of detached shock waves in stationary flows. H. CABANNES. *C.R. Acad. Sci.* [*Paris*] **236**, 1854–6 (*May* 11, 1953) *In French.*

The problem of the shock wave generated by rectilinear motion being impressed about a body having axial symmetry, at time $t = 0$, is discussed mathematically. When the permanent regime is attained rapidly, an approximate solution of the problem of shock waves detached in stationary flows is obtained. J. S. G. THOMAS

532.51 : 538.3 : 539.3 : 530.145

Integral representation of the field vector. *See Abstr.* 6456

532.517

6515. Discontinuous flow past a circular cylinder. M. KAWAGUTI. *J. Phys. Soc. Japan*, **8**, 403–6 (*May–June*, 1953).

The flow is studied making use of the theory of discontinuous flow and boundary-layer theory. The determination of the separation points is carried out by means of an iterative method. It is found that the separation angle which is measured from a forward stagnation point, is approximately equal to 58°. This angle is very close to the smallest one, 55°, among the angles of separation which can be allowed from the discontinuous flow theory. Thus the flow with separation angles of 55° seems to be the limiting case of viscous flow past a circular cylinder when the Reynolds number increases indefinitely. A.

532.543

6516. Resistance effects on hydraulic instability. R. F. DRESSLER AND F. V. POHLE. *Commun. pure appl. Math.*, **6**, 93–6 (*Feb.*, 1953).

An analysis is made of the stability of flow down an inclined open channel with different laws of resistance. Instability, observable as a progressive "roll wave," is possible if the resistance depends on both the velocity and the depth. J. G. OLDROYD

532.58

6517. The Coriolis force on a sphere in a liquid. F. BAYER-HELMS AND H. PICK. *Z. Phys.*, **134**, *No.* 5, 582–95 (1953) *In German.*

A study of the influence of a surrounding liquid on the component of force (the Coriolis force) on a moving sphere relative to rotating axes. It is shown that the flow past the sphere reduces this force and that it might even change sign for very light spheres. A null method is used experimentally to show the effect of geometry and of kinematical and hydrodynamical variables. T. C. TOYE

532.59

6518. An experimental study of standing waves. G. TAYLOR. *Proc. Roy. Soc. A*, **217**, 44–59 (*June* 9, 1953).

The experiments here described were designed to test experimentally some conclusions about free standing waves recently reached analytically by Penney and Price. A close approximation to oscillations was produced in a tank by wave ma operating with small amplitude and at frequer where great amplification occurred, owing to sonance. The amplitude-frequency curve proved consist of two non-intersecting branches, a re which can be explained theoretically. A strili prediction made by Penney and Price was that w the height of the crests of standing waves reac about 0·15 wavelength they will become pointed the form of a 90° ridge. Higher waves were expec to be unstable because the downward acceleration the free surface near the crest would exceed that gravity. The experimental conditions necessary producing a crest in the form of an angled rid were found and the wave photographed in this co dition. Good agreement was found with the c culated form of the profile of the highest wave, wh had an angle very near to 90°. The predicted stability for two-dimensional waves was found begin at the moment the crest became a sharp rid It rapidly assumed a three-dimensional charac which was revealed by two photographic techniqu Even when the amplitude of oscillation of the wa makers was only 0·85°, violent types of instabil developed which produced effects that are he recorded.

532.596 : 551.46.0

6519. Some automatic devices for use on tid models. M. J. WILKIE. *J. sci. Instrum.*, **30**, 263 (*Aug.*, 1953).

Mechanical tide-generators have a shaft whic rotates in synchronism with the tidal cycle and whic can be used to operate auxiliary equipment. Moder tide generators controlled from a graph of the desire tide have no synchronized shaft, and auxiliary equip ment is then conveniently operated by changes in th water level. A device for injecting solid material, an a system for time lapse cinephotography are described both controlled by water level. The use of a "surplus" aircraft camera for routine still photographs is also described. A

CAPILLARITY 532.6

532.61 : 537.29

6520. Action of an electric field on the spreading of certain liquids over a plane. A. BRIN AND P. COTTON. *C.R. Acad. Sci.* [*Paris*] **236**, 1485–7 (*April* 13, 1953) *In French.*

An electric field (2000 V over 6·5 mm) was applied parallel to the surface of a microscope slide on which were placed drops of various liquids. Drops of oleic acid became pear-shaped with the pointed ends towards the negative electrode. Mercury and paraffin were unaffected and water drops pointed towards the positive pole. A. L. MACKAY

532.61 : 539.133

6521. Surface tensions and covalent radii. J.-F. JOLIET. *C.R. Acad. Sci.* [*Paris*] **236**, 1259–61 (*March* 25, 1953) *In French.*

See Abstr. 4161 (1952). The surface tensions have been found proportional to the covalent radii of X,

ven when $C_nH_{2n+1}X$ is replaced by C_6H_5X, $C_6H_4\begin{cases}CH_3\\X\end{cases}$ or AX_3 (X = halogens). J. JACOBS

532.613.4

6522. Tables for use in the measurement of interfacial tensions between liquids with small density differences. O. S. MILLS. *Brit. J. appl. Phys.*, **4**, 247–525 (*Aug.*, 1953).

In order that the pendant drop method for the determination of interfacial tensions may be applied to systems with small density differences, extensions have been made to tables published by Fordham. These extensions are also useful when the interfacial tension is large or where the drop size is small, that is as the drop tends to become spherical. As a result, the combined tables are some two and a half times as extensive as before. The choice of measurements as suggested by Andreas and others has been shown to be satisfactory. A.

532.62

6523. Investigation of the instability of a moving liquid film. H. B. SQUIRE. *Brit. J. appl. Phys.*, **4**, 167–9 (*June*, 1953).

The stability of a thin layer of liquid moving in still air is studied theoretically with the object of throwing light on the break-up of films during atomization. It is found that instability occurs if $W = T/\rho_1 U^2 h < 1$ and that the wavelength for maximum growth factor, for $W \ll 1$, is $\lambda = (4\pi T/\rho_2 U^2)$ where ρ_1 is the liquid density, ρ_2 is the air density, U is the film velocity, $2h$ is the film thickness and T is the surface tension of the liquid. Comparison with experimental data shows fair agreement with the observed wavelengths. A.

532.65

6524. The distribution law of particle size from atomization. H. A. TROESCH AND P. GRASSMANN. *Z. angew. Math. Phys.*, **4**, *No.* 1, 81–5 (*Jan.*, 1953) *In German.*

Formulae are derived on classical statistics for the distribution of drops, their surface and volume. Two parameters are contained in the formulae, which fit the facts better than previous ones, the maximum drop diameter which can be calculated and the exchange factor which depends on the type of atomizer.

T. C. TOYE

532.65

6525. The production of water spray of uniform drop size by a battery of hypodermic needles. D. J. RASBASH. *J. sci. Instrum.*, **30**, 189–92 (*June*, 1953).

The assembly of a spray apparatus consisting of 169 hypodermic needles is described. This apparatus could give a concentrated flow of spray at a wide range of drop sizes and rates of flow. In the range of drop size 0·6–2·4 mm the drop size uniformity of the spray was much better than could be obtained by pressure nozzles. Coalescence of the drops while falling, however, was a factor which decreased the uniformity as compared with drops falling from a single needle. A.

532.69

6526. Spreading of liquid metals on solid surfaces. Surface chemistry of high-energy substances. A. BONDI. *Chem. Rev.*, **52**, 417–58 (*April*, 1953).

A comprehensive survey in which the extant data in the following fields are collected together and critically reviewed: (1) the thermodynamics of spreading of liquids on surfaces; (2) properties determining the spreading of liquid metals on solid surfaces, including (*a*) surface tension of liquid metals, (*b*) surface tension of fused metal oxides and metallic salts, (*c*) surface free energy of solid metals and metal oxides, (*d*) interfacial free energy between high energy substances, mostly metal/non-metal pairs (both fused), (*e*) spreading coefficient of organic substances on liquid metals; (3) wetting of solid metals by liquid metals (about 80 pairs); (4) wetting by alloys; (5) spreading on and by non-metals. It is emphasized that the strength of adhesion of a film of a liquid or solid to a solid is rarely affected by the ability to wet the surface; the contact angle has to be very near 180° before the strength of adhesion at the interface becomes smaller than the tensile strength of the bonded solid, provided the work of adhesion is high.

S. J. GREGG

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

6527. Molecular sound velocity and molecular compressibility of liquid mixtures. O. NOMOTO. Letter in *J. chem. Phys.*, **21**, 950–1 (*May*, 1953).

The molecular sound velocity $R = (M/\rho)V^{\frac{1}{3}}$, and the molecular compressibility $W = (M/\rho)\beta^{-1/7}$, (β = adiabatic compressibility) have been calculated for a number of binary mixtures of mutually soluble liquids. A more detailed account is in preparation.

T. C. TOYE

532.7 : 536.7

6528. Simplified relation between thermodynamics and molecular distribution functions for a mixture. B. H. ZIMM. *J. chem. Phys.*, **21**, 934–5 (*May*, 1953).

An equation is presented connecting the chemical potential, the compressibility, and one of the molecular pair distribution function integrals of a binary mixture. A.

533.7.08

6529. A critical comment on the paper by H. Bucka and U. v. Haselberg, on "Demonstration of the measurenent of thermal molecular velocities with an analytical balance." H. WEGENER. *Z. Phys.*, **135**, *No.* 1, 101–4 (1953) *In German.*

See Abstr. 7798 (1950). It is shown that the experiment measures the coefficient of diffusion. The agreement between the original theory and experiment is then accidental and is due to the size of the apparatus used. G. J. KYNCH

532.72

6530. Dispersion of soluble matter in solvent flowing slowly through a tube. G. TAYLOR. *Proc. Roy. Soc. A*, **219**, 186–203 (Aug. 25, 1953).

When a soluble substance is introduced into a fluid flowing slowly through a small-bore tube it spreads out under the combined action of molecular diffusion and the variation of velocity over the cross-section.

It is shown analytically that the distribution of concentration produced in this way is centred on a point which moves with the mean speed of flow and is symmetrical about it in spite of the asymmetry of the flow. The dispersion along the tube is governed by a virtual coefficient of diffusivity which can be calculated from observed distributions of concentration. Since the analysis relates the longitudinal diffusivity to the coefficient of molecular diffusion, observations of concentration along a tube provide a new method for measuring diffusion coefficients. The coefficient so obtained was found, with potassium permanganate, to agree with that measured in other ways. The results may be useful to physiologists who may wish to know how a soluble salt is dispersed in blood streams. A.

532.72 : 535.417

6531. Diffusion of polystyrene fractions in dichloroethane. V. N. Tsvetkov and S. I. Klenin. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 1, 49–52 (1953) *In Russian.*

Presents results of measurements of the diffusion in dichloroethane of polystyrene obtained by polymerization of the monomer at 60°C. The coefficients of diffusion were determined by the polarization interferometric method described in a previous paper [Abstr. 3353 (1952)], using a 0·05 g/100 cm³ concentration. For truly monodisperse systems, the coefficient of diffusion remained constant within 0–250 000 sec from the beginning of the experiment; for polydisperse systems, the coefficient decreased as time progressed. The results obtained for polystyrene fractions with molecular weights ranging from 250 000 to 1 320 000 fit into the relationship $D = 1{\cdot}12 \times 10^{-4} M^{-0{\cdot}51}$. Mathematical analysis of the coefficient when applied to the hydrodynamically equivalent sphere shows that the radii of equivalent spheres for the viscosity phenomena are, within the experimental error, proportional to the radii of equivalent spheres for the diffusion phenomena.

F. LACHMAN

532.72 : 536.2

6532. Tentative theory relating to diffusion in a moving fluid. C. Bory. *C.R. Acad. Sci.* [*Paris*] **236**, 1743–5 (*May* 4, 1953) *In French.*

Internal friction and thermal conduction, in the case of laminar or turbulent fluid motion, have been satisfactorily explained in terms of the transport of motion and kinetic energy by diffusing molecules, the apparent continuity of the phenomena arising as a statistical effect. Now, the general lines of a theory of conduction and viscosity, relating to laminar or turbulent fluid motion, arising as a continuous phenomenon associated with the fluid continuum is briefly developed. Diffusion is, for simplicity, assumed to occur in one direction only, but this restriction is to be removed in a later extended treatment.

J. S. G. THOMAS

532.72 : 536.2

6533. A theoretical study, by the method of continuity, of the mixture of fluids due to turbulence. C. Bory. *Ann. Phys.* [*Paris*] **8**, 313–37 (*May–June*, 1953) *In French.*

Mixture of liquids can occur due either to turbulence or owing to molecular agitation. Considering, first of all, diffusion in one direction in a homogeneous, isotropic medium, a very few hypotheses permit the deduction of the classical laws of thermal conductio and viscosity and their expression in terms of a sing parameter characterizing the medium. Dropping th assumption of uni-directional diffusion, it is shov that the phenomena in space are of the same type those already studied, and the diffusion theory extended to non-isotropic and heterogeneous medi The problem of the partition of velocities in flo between two parallel plates is discussed on the assump tion that the diffusing masses transport their turbu lence as in the case of heat transfer, and it is show that the theoretical results agree with experimenta results except near the boundary wall. Heterogeneiti of turbulence produces a flux of diffused matte necessitating the formation of return currents. Con ditions determining the possible application of th theory to the discussion of actual diffusion and tur bulence phenomena are briefly studied. J. S. G. THOMA

532.72 : 536.

On variational principles for irreversible processes *See Abstr.* 6740

532.74 : 536.7

Radial distribution functions for monatomic fluids *See Abstr.* 6741

532.77 : 534.21

6534. The compressibility of solutions. II. An ultrasonic study of aqueous solutions of some simple amino acids and their uncharged isomers at 25°C. F. T. Gucker, Jr, and R. M. Ha 32. *J. Acoust. Soc. Amer.*, **25**, 470–9 (*May*, 1953).

The first author showed in 1933 that the apparent molal compressibility of the solute in a dilute aqueous solution is a linear function of the square root of the concentration for electrolytes, and of the first power of the concentration for nonelectrolytes. Both of these linear relationships may hold up to fairly concentrated solutions and afford convenient interpolation formula for the compressibility as a function of concentration. The conclusion about electrolytes has been confirmed by several others, but little has been done with nonelectrolytes. This article describes a 4 Mc/s interferometer used to determine adiabatic compressibilities of solutions to about ±0·01%. Studies of several amino acids and their uncharged isomers, including glycine and glycolamide, α- and β-alanine and lactamide, from about 0·05 M to near saturation, show linearity with concentration in dilute solutions and a general increase in the limiting slope and decrease in the limiting value of the apparent molal compressibility with increasing dipole moment of the solute molecules. These results are interpreted qualitatively by the theories of dipolar interaction developed by Fuoss and Kirkwood, and of dipolar charging energy developed by Kirkwood, but systematic deviations are observed for the apparent molal compressibilities and the volumes and heat capacities. A.

MECHANICS OF GASES 533

533.1

6535. Laminar and turbulent stationary streams of air and CO_2 in a slightly conical tube in the neighbourhood of the critical Reynolds number. O. Lauer. *Z. angew Phys.*, **5**, *No.* 3, 81–90 (1953) *In German.*

An experimental investigation. In general, agree-

ment with theory is established for convergent and divergent laminar flow and also for convergent turbulent flow. For divergent turbulent flow, however, the results do not agree exactly with theoretical predictions. T. C. TOYE

533.16

6536. The viscosity of gas mixtures. H. R. HEATH. *Proc. Phys. Soc.* [*London*] *B*, **66**, 362–7 (*May*, 1953).

The viscosity of binary mixtures over the complete range of concentration was measured in the case of He–A, He–N_2, He–CO_2 and H_2–A, H_2–N_2, H_2–CO_2. All the measurements were made at 18°C and 70 cm of mercury pressure by a modified form of Rankine viscometer. The results are in very good agreement with the values calculated from Chapman's theory. Values for the first approximation to the diffusion coefficient $(D_{12})_1$ are obtained from the results, and these are in approximate agreement with measured values where the latter are available. A.

533.21 : 536.7

6537. Isotherms and thermodynamical functions of propene at temperatures between 25° and 150°C and at densities up to 340 amagat (pressures up to 2800 atm.). A. MICHELS, T. WASSENAAR, P. LOUWERSE, R. J. LUNBECK AND G. J. WOLKERS. *Physica*, **19**, 287–97 (*March*, 1953).

533.56

6538. A study on diffusion pump oil by the mass spectrometer and the gas analysis of the final vacuum. K. HISATAKE AND K. MATSUDA. *J. Phys. Soc. Japan*, **8**, 416–21 (*May–June*, 1953).

Diffusion pump oil is analysed by the mass spectrometer, chiefly for the purpose of obtaining some knowledge about the residual gases at the final vacuum. As a sample, we take alkyl-naphthalene and its spectrum is given graphically. The results of the analyses of residual gases confirm the conclusions obtained by Hickman and Blears. A.

533.56

6539. An assessment of some working fluids for diffusion pumps. D. LATHAM, B. D. POWER AND N. T. M. DENNIS. *Vacuum*, **2**, 33–49 (*Jan.*, 1952—publ. *Nov.*, 1952).

Since oils were first suggested as alternatives to mercury as pumping fluids for diffusion pumps, a very large number of organic and semi-organic materials have been applied to this use. All these have differing characteristics which may affect the choice of fluid for a particular application, while the use of mercury itself is still essential in some cases and desirable or at least defensible in others. The authors discuss how some of the characteristics of a selection of pumping fluids would influence a user in his choice, and illustrate the discussion with some of their own experiences and experiments. A.

533.59

6540. Leak detection practice with particular reference to the hydrogen palladium method. N. OCHERT AND W. STECKELMACHER. *Vacuum*, **2**, 125–36 (*April*, 1952—publ. *April*, 1953).

The principles of leak detection are discussed with specific reference to the Pirani and palladium-barrier ionization gauges, as used to detect hydrogen applied externally as a test gas. Plant based on these techniques, with the detector in the backing space and other refinements, are described. The testing of single or multiple vessels based on this type of plant is discussed in detail with special reference to applications outside the vacuum field. The problem of leak testing completely sealed components is also discussed. The paper concludes with a consideration of calibrated reference leaks, for a quantitative assessment of the leakage rate, when testing to a specification. A.

533.59 : 531.788.7

6541. A cylindrical magnetron ionisation gauge. A. H. BECK AND A. D. BRISBANE. *Vacuum*, **2**, 137–46 (*April*, 1952—publ. *April*, 1953).

This report describes a new vacuum gauge in the form of an inverted cylindrical magnetron. This gauge is useful in the pressure range 10^{-4} to 10^{-8} mm Hg. The main advantages over existing gauges are a much higher current output at a given pressure and the elimination of elaborate devices for emission stabilization. It is very well adapted for use in a bridge-type leak detector using butane as a probe gas, and a leak detector using these tubes has indicated leaks of less than 10^{-6} lusec. The best figure claimed for the mass spectrometer is 10^{-7} lusec, so the sensitivities of the two leak detectors are of the same order. A.

533.59 : 531.788.7

6542. On the operation of the Penning gauge. M. BAYET AND G. DOMAS. *C.R. Acad. Sci.* [*Paris*] **236**, 1648–50 (*April* 27, 1953) *In French.*

The authors investigated the noise from the discharge in a Penning gauge while maintaining the vacuum (10^{-3} mm Hg) and the parallelism of the magnetic field carefully. In the wavelength range 3 to 0·50 m, a more or less continuous frequency spectrum was observed, and a sharp maximum at a frequency of less than half the gyromagnetic value; this is explained in terms of a radial electric field. At very low pressures, the discharge ceases as the p.d. is raised; this is explained by the shortening of the spiral trajectories. T. J. REY

533.59 : 531.788.7

6543. Sorption and desorption of gas in the cold-cathode ionization gauge. J. H. LECK. *J. sci. Instrum.*, **30**, 271–4 (*Aug.*, 1953).

The rate of clean-up, between 10^{-6} and 10^{-4} mm of mercury, has been measured for a variety of gases and vapours, such as nitrogen, argon and water vapour. The effect on the accuracy of the gauge has been estimated. The errors introduced depend both on the design of gauge and on the gas present in the vacuum system. A.

533.6.011 : 541.115

6544. Possibility of relating a gaseous flow with heat production or chemical reaction to an isotropic flow without chemical reaction. M. SERRUYS. *C.R. Acad. Sci.* [*Paris*] **236**, 1341–3 (*March* 30, 1953) *In French.*

A duct of variable cross-section Σ is postulated, for which the formula for the change in velocity dW/W from [Abstr. 1433 (1953)] is valid. An approximate expression for Σ is given. C. TURNER

533.6.011.4

6545. On the non-existence of limiting lines in transonic flows. C. S. MORAWETZ AND I. I. KOLODNER. *Commun. pure appl. Math.*, **6**, 97–102 (*Feb.*, 1953).

Flows past airfoils, which are irrotational and

subsonic for low Mach numbers, at large distances from the airfoil, are discussed mathematically. A number of mathematicians have shown that if flows and their profiles are constructed, using solutions in the hodograph plane, which depend continuously on some Mach number, there is always a critical Mach number where the mapping of the hodograph plane into the physical plane breaks down; the image in the physical plane has a fold in the supersonic region whose edge is called "the limiting line." The Jacobian of the transformation from the hodograph plane to the physical plane vanishes along this limiting line. It has also been proposed that continuous flow past a fixed airfoil also breaks down because of the appearance of a limiting line, and it has been shown that such limiting line would have to start on the sonic curve. Friedrichs [*Commun. pure appl. Math.*, **1**, 287–301 (*March*, 1948)] has shown that limiting lines cannot appear in analytic flows which depend continuously on the entrance Mach number, and that, therefore, the breakdown of potential flow must be due to other causes. In the proof of Friedrichs's theorem now presented the condition of analyticity is dispensed with, and it is shown that only continuous second derivatives of the stream function are required. It is also shown that in the construction of flows past continuously changing profiles, the incidence of a limiting line corresponds to a profile of infinite curvature.

J. S. G. THOMAS

533.6.011.5

6546. On boundary layers and upstream influence. II. Supersonic flows without separation. M. J. LIGHTHILL. *Proc. Roy. Soc. A*, **217**, 478–507 (*May* 21, 1953).

For Pt I, see Abstr. 4657 (1953). When any boundary layer on a straight wall is subjected to an expansive steady disturbance (either an incident wave, or departure of the wall shape from straight), or when a turbulent layer is subjected to a fairly weak compressive one, an interaction between the main stream (if supersonic) and the boundary layer is set up but the layer does not separate. Such an interaction is here treated mathematically by an extension of the author's method of perturbing a parallel flow and neglecting the disturbances of the viscous forces. It is shown that these are non-negligible only in an "inner viscous sublayer," in which the Mach number remains small, and which for the turbulent layer is inside the so-called laminar sublayer. Further, if the disturbances are Fourier-analysed longitudinally, then the effect of the inner viscous sublayer on the behaviour of each harmonic component outside it is exactly as if there were a solid wall at a certain position in the stream, with no flow across it and inviscid flow outside it. This position depends on the wave number k and on the skin friction in the undisturbed layer. This new boundary condition is now inserted into the old theory. Solutions are obtained for large and small k and used to deduce, respectively, (i) the principal local features of both the wall-pressure distribution and the flow outside the boundary layer, and (ii) the extent of upstream influence. An interpolation between them is used in an attempt to predict the complete form of the reflected wave when a shock is incident upon a turbulent layer. Reasonable agreement with experiment is obtained. The paper ends with a discuss of the skin friction distribution and how it influen the onset of non-linearity.

533.6

6547. A float type airflow meter for use on beds agricultural grains. W. F. WILLIAMSON AND MCCLOY. *J. sci. Instrum.*, **30**, 207–8 (*June*, 1953).

An instrument has been designed to measure t rate of flow of air leaving any position on the surfa of a bed of agricultural grain. A tapered tube a float meter is employed mounted on a collecting co 9 in. in dia. and the range is 7–28 ft³/min per squa foot of surface area. Calibration tests have show that a common direct reading scale can be employe to give an accuracy of ±7% on airflow using a common farm grain.

MOLECULAR THEORY OF GASES 533.7

533.

6548. The limiting thickness of an electrolyzed ga film capable of sustaining a given negative pressure L. J. BRIGGS. *J. chem. Phys.*, **21**, 779–81 (*May*, 1953).

The critical thickness of a gas film that is just capabl of withstanding a given negative pressure P_N in liquid column has been studied. The film was gene rated electrolytically on the surface of a spherica platinum electrode of known area. The number o gas molecules corresponding to the measured charge required to release the negative column was then com puted from the relation between the Faraday constant and Avogadro's number. The number of gas mole cules required to form a monolayer on the electrode was next computed from the molecular diameter, based on the van der Waals equation. The ratio of these numbers gives the "thickness" t of the film in fractions of a monolayer. Both O_2 and H_2 gas films were measured under conditions such that the same number of gas molecules were deposited on the same electrode and the corresponding critical negative pressures observed. Assuming the effectiveness of the film to be proportional to the area covered, the ratio of the diameters of the O_2 and H_2 molecules is inversely proportional to the square root of the ratio of their critical negative pressures. This gave $O_2/H_2 = 1{\cdot}11$ as compared with 1·06 from measurements based on the van der Waals equation. Measurements of oxygen films were made at various negative pressures, ranging from $P_N = 90$ cm water, $t = 0{\cdot}55$ monolayer, to $P_N = 4$ cm, $t = 0{\cdot}87$ monolayer. The results lie on a smooth curve down to $P_N = 10$ cm, t increasing steadily as P_N is reduced. Below $P_N = 10$ cm, the thickness of the film no longer increases, indicating that the zone of influence of the gas molecule extends beyond its projected area.

A.

533.7 : 539.13

6549. The molecular polarisation of compressed non-polar gases. J. DE BOER, F. VAN DER MAESEN AND C. A. TEN SELDAM. *Physica*, **19**, 265–78 (*March*, 1953).

The theory for the change of the Clausius–Mosotti function of non-polar gases under pressure, for a non-polar gas of interacting molecules is further

eveloped on the basis of the statistical theory itiated by Kirkwood. The Clausius-Mosotti nction is developed as a power series in powers of e density, the coefficients of which are expressed in rms of the polarizabilities and the intermolecular orces. The linear and the quadratic terms have been valuated analytically or numerically for a Lennard–ones (12–6) potential field and for a Herzfeld otential field. The results of the calculations are ompared with recent measurements of Michels, Ten eldam and Overdijk on the Clausius-Mosotti function f compressed argon. A.

533.72

6550. The direct measurement of the isothermal Joule–Thomson coefficient for gases. A. CHARNLEY, G. L. ISLES AND J. R. TOWNLEY. *Proc. Roy. Soc. A*, **217**, 133–43 (*June* 9, 1953).

A new apparatus is described for measuring the sothermal Joule–Thomson coefficient. The results obtained agree well with other direct measurements and also with adiabatic Joule–Thomson and compressibility data. The gases investigated are nitrogen, ethylene, carbon dioxide and nitrous oxide, in the range 0 to 45°C and 0 to 45 atm. A.

533.75

6551. The general relation between the density virial coefficients and the pressure virial coefficients. W. E. PUTNAM AND J. E. KILPATRICK. Letter in *J. chem. Phys.*, **21**, 951 (*May*, 1953).

This is calculated by integration of $\sum_{=0} D_j x^j = \sum_{k=0} C_{lc} P^k_k$ multiplied by a suitable factor. C. TURNER

VIBRATIONS . ACOUSTICS 534

534.014.5 : 621.317.353

6552. On the rigorous proof of a method of measuring non-linear distortion on an intermodulation basis. H. SÖDING. *Frequenz*, **7**, 127–33 (*May*, 1953) *In German.*

The inherent distortion of a system can be defined by the amount of intermodulation present when it is simultaneously excited by two pure sine waves of different frequency. The author describes a method of measuring this intermodulation factor by demodulating the principal sideband spectrum (higher frequency $\pm m \times$ lower frequency) by means of a half-wave detector of linear characteristics, and gives a rigorous mathematical proof of its validity.

H. O. F. FRIEDHEIM

534.21

6553. On the spreading of sound in media with random fluctuations in refractive index. V. YA. KHARANEN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 2, 253–6 (1953) *In Russian.*

Derives a theoretical expression for the deviation of a sound wave passing through a region with random fluctuation of refractive index in terms of the Markov process and the auto-correlation coefficient for the refractive index. It is suggested that this may provide an explanation of the "absorption plane" over the sea.

J. M. HOUGH

534.22

6554. A new precision method for the measurement of ultrasonic velocities in liquids. B. R. RAO AND K. S. RAO. Letter in *Nature* [*London*] **171**, 1077–8 (*June* 13, 1953).

The Debye–Sears diffraction method is used with a quartz X-cut wedge of 1–3 Mc/s range with the X-axis vertical and with the tapered edge parallel to the light beam. The ultrasonic waves are communicated to liquid 4 cm deep in a glass cell in a levelling stand, and a stationary ultrasonic diffraction grating is set up in the liquid at those frequencies for which the liquid column is in resonance. The frequencies of a number of diffraction maxima were measured and found equally spaced at differences within the range 0·01 to 0·03 Mc/s for various liquids. About 100 maxima were measured to obtain the precise difference between two consecutive maxima and then the ultrasonic velocity was computed from the formula $V = \Delta f \times 2L$ where L is the length of the liquid column. The accuracy of the results is 0·2% and values are given for five liquids. A. C. WHIFFIN

534.22

6555. Dispersion of ultrasonic velocity in sodium acetate solutions. A. F. CHHAPGAR. Letter in *J. Acoust. Soc. Amer.*, **25**, 793 (*July*, 1953).

Absorption measurements on sodium acetate solutions have shown the existence of a relaxation phenomenon at a frequency less than 7 Mc/s. An attempt is made in the present paper to determine the existence of velocity dispersion near this frequency. No dispersion is detected. A.

534.22

6556. Ultrasonic velocities in solutions and mixtures. A. F. CHHAPGAR. Letter in *J.Acoust. Soc. Amer.*, **25**, 794–5 (*July*, 1953).

In a recent paper [Abstr. 7121 (1952)], Maier and Mez have reported a maximum in the absorption-concentration curve for a phenol-carbon tetrachloride solution at small phenol concentrations, which was ascribed to association resulting from hydrogen bonds. The present paper investigates the behaviour of the velocity-concentration curve for the same solution. The results show a departure from linearity at low concentrations, agreeing with the results of Maier and Mez. A.

534.22 : 532.13

6557. Relation between velocity of sound and viscosity in liquids. S. PARTHASARATHY AND N. N. BAKHSHI. *Proc. Phys. Soc.* [*London*] *B*, **66**, 368–70 (*May*, 1953).

A new relationship, viz. $v^{1/3}/\rho = A + B/\eta^{1/2}$, between sound velocity v, viscosity η and density ρ of a liquid, has been obtained. It is observed that A is a constant (=13·56) for all the homologous series considered, whereas B is different for different series, A plot of $v^{1/3}/\rho$ against $1/\eta^{1/2}$ gives a set of straight lines diverging from the same point on the y-axis (0, 13·56). A.

534.23

6558. Determination of ultrasonic absorption coefficient in liquids by a new technique. S. PARTHASARATHY, S. S. CHARI AND P. P. MAHENDROO. Note in *Z. Naturforsch.*, **8a**, 272–3 (*April*, 1953).

Previous work by the authors showing a relation between the initial intensity of sound in a liquid and

the heat produced affords a new method for determining α. The rise in temperature of the liquid contained in a double walled glass calorimeter at varying distances from the source is measured and hence α is determined from the equation $H = H_0 e^{-2\alpha x}$. The calorimeter and source are both immersed in the liquid and the sound enters through a thin mica window in the calorimeter. T. C. TOYE

534.23 : 537.32

6559. A thermoelectric method of comparing intensities of ultrasonic fields in liquids. R. B. J. PALMER. *J. sci. Instrum.*, **30**, 177–9 (*June*, 1953).

A new type of indicator is described dependent upon the rise in temperature of certain materials due to the absorption of ultrasonic radiation incident upon them. Experiments are described in which the behaviour of the indicator is compared with that of a radiation pressure detector. Examples are given of its use. A.

534.232 : 534.862.3 : 621.395.625.3

6560. Storage technique for sound measurement. H. ETZOLD. *Funk u. Ton*, **7**, 307–15 (*June*, 1953) *In German.*

Investigation into the behaviour of electro-acoustic transducers, such as condenser and moving-coil microphones, at very low levels and with signals of short duration is greatly helped by the use of magnetic-recording technique. In particular, the suspected non-linearity of operation at levels from just above noise level downwards, due perhaps to the extremely small movements involved or to thixotropic behaviour of the moving parts, can be examined. A standard domestic tape recorder was selected and modified to the extent of improving the filtering, making the frequency characteristic as linear as possible, and adding a stroboscopic disc to the capstan. Ancillary equipment consisted of attenuators, amplifiers and level-indicating meters. With the test microphones, a condenser and a special resonance-type moving-coil microphone, connected to the input of the equipment, recordings were made above and below noise level. Subsequent oscillograms taken from the recorded tape showed no signs of non-linearity at these low levels. The equipment is considered suitable for psycho-acoustic investigations at low level, and for heart-beat and crystal-noise study. H. G. M. SPRATT

534.232 : 551.46

6561. The mechanism of generation of infrasound by the ocean waves. F. B. DANIELS. Letter in *J. Acoust. Soc. Amer.*, **25**, 796 (*July*, 1953).

534.232 : 621.3.017.143 : 621.315.612.4

6562. Electromechanical response and dielectric loss of prepolarized barium titanate under maintained electric bias. I. H. G. BAERWALD AND D. A. BERLINCOURT. *J. Acoust. Soc. Amer.*, **25**, 703–10 (*July*, 1953).

In transducer applications of ferroelectric ceramics it is standard practice to rely for the electromechanical response on retained polarization. This is practicable only for moderate driving amplitudes and sufficiently low temperature. At higher driving fields dielectric losses increase inordinately and lead to eventual depolarization and loss of response. This can be remedied by application of a comparatively modest d.c. bias. The quantitative loss behaviour of various ceramic bodies over extended ranges of temperature, field amplitude, and for various values of aiding b is investigated. Results are also presented on vari other effects obtained with bias operation, such increase of electromechanical coupling and shifts thermodynamic transition points.

534.232 : 621.

6563. The equivalence of optimum transducers a sufficient and most efficient statistics. G. W. PRESTO *J. appl. Phys.*, **24**, 841–4 (*July*, 1953).

The problem of the design of transducers for t purpose of restoring the fidelity of a signal (which h been corrupted by noise), while preserving inform tion in the sense of Shannon is shown to be a particul though unusual one of statistical inference and to amenable to the methods of mathematical statisti Adopting the view that the inference of the appro mate form of a function $s(t)$ (the signal) from th available mixture of the signal and the noise tim series $n(t)$ is the natural limiting case of inference fro discrete series of random variables, it is seen that th transducer under discussion is the physical analogu of a "statistic"—in the sense of Fisher—and that th properties of the optimum transducer are equivalen to the statistical properties of sufficiency (preservatio of information) and efficiency (maximization c fidelity). The case of a Gaussian signal to whic Gaussian noise has been added is considered in detai Using the probability density functional of the Gaus sian time series, the maximum likelihood estimat (which in this case is efficient, hence sufficient) of th signal is derived, and its physical analogue is identifie as the smoothing filter of Wiener with infinite lag. A

534.232 : 621.395.6

6564. Graphical aids in interpreting the performanc of crystal transducers. W. G. CADY. *J. Acoust. Soc Amer.*, **25**, 687–96 (*July*, 1953).

When the mechanical damping of a transducer i large, as by acoustic radiation from one or both face into a liquid or solid, the circular diagram that repre sents its characteristics requires special treatment As a background for this treatment, the uses an limitations of the conventional circle for a resonato with small losses is first reviewed. The problem o the transducer with large losses is then considere with special reference to the equations and graph for a thickness-type transducer with unsymmetrica loading. For plane-wave transducers the expression are exact for all loads and at all frequencies, includin harmonics. Either the voltage or the current may b constant. From the admittance or impedance dia grams the magnitude and phase of current, voltage particle velocity and vibrational amplitude at an frequency can be obtained immediately. Simila results would be found with plates in lengthwis vibration. A new type of diagram is developed fo respresenting vibrational amplitudes. As an illustra tion, the case of a quartz plate radiating into thre liquids of widely different acoustic properties i treated. When the load is unsymmetrical, there is n true node anywhere in the crystal except when th load is zero or infinity. There is, however, a plane o minimal vibration, the amplitude and location o which are derived. The equations indicate certai peculiar effects when the specific acoustic resistanc of the medium is just twice that of the crystal. A

534.232 : 621.395.62

6565. Design techniques for a high frequency transducer with a wide-beam searchlight pattern. A. L. ANE. *J. Acoust. Soc. Amer.*, **25**, 697–702 (*July*, 1953).

It was found that a barium titanate spherical shell ector properly designed will meet these difficult wide-attern and high frequency specifications. This paper utlines some of the design considerations required to dapt a ceramic shell into a transducer with the esired performance. The problems discussed are hell size, included angle of the spherical shell, inside iameter to thickness ratio, and the uniformity of the hickness dimension. Various baffle techniques are lso examined in detail. Shell arc lengths ranging from to 20 wavelengths are considered as to their effects n the shape of the surface displacement distribution nd on the directivity pattern. The design techniques iscussed are applicable to transducers having other requency and pattern requirements. A.

534.232 : 621.395.623

6566. Anomalous transient response of a crystal pick-up. P. M. HONNELL. *J. Acoust. Soc. Amer.*, **25**, 570–4 (*May*, 1953).

The true transient response of a piezoelectric vibration pick-up (Brush type BL-301) to square waves and steps of displacement has been obtained with a transient-testing transducer system. The anomalous response of the pick-up to these transient motions is in the nature of superimposed oscillations of high frequency. These spurious oscillations in the step response have their counterpart in the multiple resonances of the crystal element as indicated by the steady-state cissoidal calibration of the pick-up. A.

534.24 : 551.46

6567. Reflection of sound in the ocean from temperature changes. R. R. CARHART. *J. appl. Phys.*, **24**, 929–34 (*July*, 1953).

When the temperature of the ocean changes with depth within a horizontal layer, it is accompanied by a change in the velocity of sound. The reflection of sound from such a transition layer depends on the incident angle and wavelength of the sound, the thickness of the layer, the manner in which the velocity changes, and the total amount of the change. The usual formula for reflection assumes a transition layer of negligible thickness. The reflection coefficient then depends only on the incident angle and the total velocity change. This case is treated and numerical values are given for the reflection coefficient under conditions of practical interest. It is then shown that for a gradual velocity change which corresponds to certain temperature data, the reflection coefficient for small glancing angles of incidence changes gradually with increasing layer thickness and may be approximated very closely by the usual formula. Quantitative comparison of the cases is made and the general applicability of the approximation is discussed. A.

534.3

6568. Study and representation of complex sounds in musical acoustics. A. MOLES. *Funk u. Ton*, **7**, 277–87 (*June*, 1953) *In German.*

After remarking on the inherent complexity of musical sounds, e.g. intensity and frequency variations with time, the author discusses various methods of diagrammatic presentation of the various factors involved. In one arrangement he represents a complex tone in a 3-dimensional diagram—dividing into 3 planes, the harmonic plane, dynamic plane and the melodic plane. Various other arrangements of this nature are suggested. A. B. WOOD

534.37

6569. A note on the acoustic boundary dissipation due to viscosity. A. F. KUCKES AND U. INGÅRD. Letter in *J. Acoust. Soc. Amer.*, **25**, 798 (*July*, 1953).

A mathematical note dealing with the energy losses due to viscous dissipation in the regions close to boundaries of the sound field where large velocity gradients occur in the boundary layer. In the case of an aperture in a thin plate, almost the entire dissipation is associated with a region very close to the hole and the curved part of the boundary. The result is therefore strongly dependent on the value of surface resistance of the curved part. A. B. WOOD

534.37 : 621.395.62

6570. Magnetic dispersion of sound in electrically conducting plates. D. H. ROBEY. *J. Acoust. Soc. Amer.*, **25**, 603–9 (*July*, 1953).

It is shown theoretically that plane longitudinal sound waves travelling in an electrically conducting plate will generate complex electric currents provided there is a magnetic induction perpendicular to the particle displacement. The currents react with the induction to produce a complex mechanical force which opposes the particle motion. The impedance associated with this force effectively modifies the impedance of the medium by adding a resistance and a stiffness reactance. The induced resistance attenuates the waves while the induced stiffness increases Young's modulus and therefore increases the sound velocity. Of all the elements, it appears that this effect is a maximum in lithium, i.e. at a given frequency and induction. A.

534.39

6571. Note on the paper "Radiation pressure and dispersion." E. J. POST. Letter in *J. Acoust. Soc. Amer.*, **25**, 797 (*July*, 1953).

Reference is made to a previous paper [Abstr. 2287 (1953)] by the author. It is now pointed out that, after Rayleigh, Brillouin dealt with the dispersion feature of radiation pressure. A. B. WOOD

534.39

6572. Momentum and inertia properties of acoustic waves. E. J. POST. Letter in *J. Acoust. Soc. Amer.*, **25**, 797–8 (*July*, 1953).

The paper deals with the application of the conception of semi-permeable walls to the much-discussed question of momentum of acoustic waves. A semi-permeable wall in acoustics is defined as a wall permeable to the medium but impermeable to the wave motion. In "phonon" language the wall will be called impermeable to the phonons but permeable to the constituent particles of the medium itself. The change in momentum per unit time of a stream of phonons that hits an absorbing "phonon" wall at normal incidence provides an expression for the radiation pressure on the wall. A. B. WOOD

534.642

6573. Measurement of acoustic impedance by a resonance method. M. FERRERO AND G. G. SACERDOTE. *Alta Frequenza*, **22**, 3–16 (*Feb.*, 1953) *In Italian.*

An investigation of the method due to Harris [Abstr. 3199 (1948)]. The material to be measured is prepared in the form of a thin disk and inserted transversally across a tube. Close fitting pistons are placed at a distance on either side of the disk so that the latter occupies a middle position in a cylindrical cavity. Each piston has a small central bore so that acoustic energy may be fed in and out of the cavity. By connecting a source of sound and a receiver respectively at the outer ends of these bores the acoustic response of the cavity may be measured first without, then with the disk. An expression is first derived for the acoustic impedance of the disk in terms of observable quantities. A number of measured results are presented which show the variation in acoustic resistance and reactance of a disk as a function of its position and of frequency. S. C. DUNN

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 7378

534.78

6574. On the band width of vowel formants. B. P. BOGERT. Letter in *J. Acoust. Soc. Amer.*, **25**, 791–2 (*July*, 1953).

Measurements were made on a sample of vowel utterances, by male talkers, of the band widths of the first three formants. It was found that the band width was essentially constant and independent of the particular vowel. The mean values for bars 1, 2 and 3 were 130, 100 and 185 c/s, respectively. 10% of the 300 band widths measured were less than 90 c/s and 10% greater than 260 c/s. A.

OPTICS . RADIATION . SPECTRA 535

535.12

6575. Demonstration of wave interference and in particular group velocity. R. E. GLOVER, III. *Z. Phys.*, **134**, *No.* 5, 564–5 (1953) *In German.*

A simple lecture demonstration. A spiral drawn on a lantern slide gives, when rotated, a picture resembling an expanding circular wave. Superimposing two such spirals, one of a slightly greater pitch, gives a demonstration of interference and, when the speeds of rotation are different, of group velocity. S. TOLANSKY

535.135 : 538.566 : 548.7

6576. Propagation of electromagnetic waves through a crystal plate. KH. YA. KHRISTOV. *Izv. Bulg. Akad. Nauk*, **2**, 3–12 (1951) *In Bulgarian.*

A new and more accurate method to replace those of Laue, Born and Ewald is presented. The problem solved is that of a plane-parallel crystal plate cut at right angles to one of the axes of the rhombic system. A monochromatic linearly-polarized plane wave is incident normally on the plate. The ions of the plate are considered as a system of electric dipoles of three-fold periodicity, each of the dipoles oscillating harmonically under the effect of the field of the incident wave and of the waves emitted by the other dipoles. The dipole oscillations and the distribut of the electromagnetic field in front of, behind a inside the crystal plate are determined. The solut of the problem is reduced to solving a system of lin equations whose number corresponds to the numi of the cell strata in the crystal plate. B. F. KRA

535.135 : 538.566 : 54

6577. Propagation of X-rays through a crystal pla KH. YA. KHRISTOV. *Izv. Bulg. Akad. Nauk*, **2**, 15— (1951) *In Bulgarian.*

In a previous paper (preceding abstract) t problem of the molecular-optical interpretation of t transmission of electromagnetic waves through plane-parallel crystal plate was reduced to the solutio of a system of linear equations, the number of whic is equal to that of the cell strata of the plate. Th increases, accordingly, very rapidly with the thickne of the plate. The present paper proposes an approx mate solution of the same problem in which th solution of the system of equations referred to replaced by the solution of another system of equa tions, which is independent of the thickness of the plat and depends only on the accuracy of the solutio required. This is proved by showing that by a appropriate choice of monochromatic waves propa gated in both directions from the normal to the plate with appropriate velocities and dampings, the dipol oscillations may be correctly represented. The equation determining these velocities and dampings being a transcendental equation, was found, and the distribution of its roots, for which approximate formulae are presented, was determined. The distri bution of the dipole oscillations for the chosen form of the incident wave then represents a linear com bination of plane waves of the kind referred to. The coefficients of this linear combination are found as a solution of another system of linear equations, yielding the directions, amplitudes and polarization states of all the diffracted waves. The permissibility of the simplifying assumptions is demonstrated by the equality of the energy flow in front of and behind the crystal plate. B. F. KRAUS

535.135 : 538.566 : 548.7

6578. The propagation of light waves through a crystal plate. KH. YA. KHRISTOV. *Izv. Bulg. Akad. Nauk*, **2**, 33–46 (1951) *In Bulgarian.*

The problem first solved for electromagnetic waves in general by an accurate method and then by an approximation method for X-rays (preceding abstracts) is now considered for comparatively long, i.e. optical, waves on the approximate method. The distribution of dipole moments and electromagnetic field in front of, behind, and inside the plate may be represented as a sum of an average distribution and a micro-distribution. The first is an average of the real distribution over a region the centre of which is at the point for which the average of dipole moment and field are found, the dimensions of which are $\ll$ length of incident wave, but $\gg$ size of crystal cell. Micro-distribution represents the correction to be added to the average distribution for obtaining the real distribution. The average distribution of the dipole moments is given by two monochromatic plane dipole waves travelling in both directions from the normal, the average field distribution being identical with

at of Maxwell's phenomenological crystal optics. icro-distribution has 2 components, one of which the correction to the average distribution, due to e influence of the boundary surfaces of the crystal the dipole oscillations (thus noticeable near these rfaces), the second concerning only the electro-agnetic field and varying considerably in every cell, principal value near any dipole representing the herical wave emitted by this dipole. B. F. KRAUS

535.137 : 537.311.62

The anomalous skin effect and the reflectivity of etals. II. Comparison between theoretical and experi-ental optical properties. *See Abstr.* 6788

535.214

579. Pressure of radiation. R. V. JONES. *Nature [London]* 171, 1089–93 (*June* 20, 1953).

This article, the substance of a Discourse at the oyal Institution, reviews the theoretical and experi-ental study of the pressure of radiation. It is shown hat all theories of radiation pressure predict that hen light passes into a denser medium it gains omentum in proportion to the increase in refractive dex. Some recent experiments are described in hich this effect is directly observed [see Abstr. 092 (1951)]. D. G. AVERY

535.214.4 : 535.241.44

580. Radiometer calibration for extended-source easurements. F. E. NICODEMUS. *J. Opt. Soc. Amer.*, 3, 547–9 (*July*, 1953).

A calibration method is described which makes it ossible to measure the brightness or steradiancy of n extended source with a photometer or radiometer hich may have nonuniform directional response. A uniform extended source of limited size is succes-ively observed, first as a point source and then as an nfinite extended source, with the same radiometer. A circular aperture, slightly larger than the radiometer ens, is illuminated through diffusing sheets of opal lass. The brightness of this source is computed from he total intensity measured with the radiometer at a distance large enough to permit use of a "point-source" calibration scale. Then the radiometer is brought up to the source, where both aperture and field are completely filled, to obtain the response to an "infinite" extended source of known brightness. A.

535.223 : 538.565

6581. Proposed use of a cylindrical surface wave resonator for the determination of the velocity of short electromagnetic waves. H. M. BARLOW AND A. E. KARBOWIAK. *Brit. J. appl. Phys.*, **4**, 186–7 (*June*, 1953).

It is proposed to set up a surface wave resonator consisting of a length of smooth bare wire acting as the guide and short-circuited at both ends by large flat conducting plates mounted at right angles with the guide. Energy would be supplied to the resonator at a frequency between 1000 and 40 000 Mc/s using either a coaxial or loop coupling and a similar device would be employed for the detector. From a knowledge of the guide wavelength, the frequency and the radial propagation coefficient of the wave in the air surrounding the guide, the corresponding T.E.M. wave velocity can be determined and thence c deduced for vacuum conditions. Attention is drawn to certain helpful features of the method but no attempt is made to assess its ultimate accuracy in comparison with other techniques whose value has been established for this purpose. A.

535.233 : 536.521

6582. A portable wedge spectrograph for precision measurement. J. A. HALL. *Photogr. J. B.*, **92**, 170–7 (*Nov.–Dec.*, 1952).

Colour and brightness temperatures are measured simultaneously by the carefully controlled spectrographic exposure of a photographic plate to the unknown source and to a range of comparison spectra provided by a calibrated tungsten lamp. Temperatures of liquid steel from about 1450°c to 1750°c may be determined with an accuracy of ± 5°c by this method. A.

535.24

6583. Maximum or minimum photometer. O. REEB. *Lichttechnik*, **4**, 188–90 (*July*, 1952) *In German.*

This instrument is based on the use of apparatus which superimposes light from both sources on the photometer field. The photometric adjustment is such as to cause one light to increase while the other is diminished, each of these changes taking place according to a definite law. When the combined illumination is adjusted to a maximum or a minimum, the relative intensities of the two sources can be calculated from the extent of the adjustment made. For example, the sources may be fixed and the combined light may fall on a surface which moves between them, so that each illumination is varied according to the inverse square law, one increasing as the other diminishes. The position at which the combined illumination is a minimum gives the relative intensities of the sources. J. W. T. WALSH

535.24

6584. Methods of appraisal and measurement for retro-reflecting materials. P. JAINSKI. *Lichttechnik*, **5**, 40–2 (*Feb.*); 68–70 (*March*, 1953) *In German.*

Describes the various forms of test applied in different countries to reflector materials such as beaded screens and the like. The specifications and methods of test show a wide diversity and the author makes suggestions for unification. J. W. T. WALSH

535.24 : 621.327.43

6585. Curvilinear light sources. F. B. CARACCIOLO. *Elettrotecnica*, **40**, 104–7 (*March* 10–25, 1953) *In Italian.*

Treats the problem of a curvilinear light source with a luminance (brightness) distribution like that found by the author for fluorescent lamps [Abstr. 8764 (1952)]. The results are applied to determine the curve of light distribution of an annular source. J. W. T. WALSH

535.24 : 621.329

6586. Measurement of flux and efficiency of fittings of considerable length. R. G. WEIGEL AND H. RIES. *Lichttechnik*, **4**, 326–8 (*Dec.*, 1952) *In German.*

Discusses the problem of determining light distribution curves for long fittings such as those used with fluorescent lamps and of calculating from these the luminous flux output and the efficiency of a fitting. J. W. T. WALSH

535.24 : 621.329.1

6587. Special screw socket for use in the precise measurement of filament lamps. W. Leo, H. Schleicher and K. Stübenrath. *Lichttechnik*, **4**, 190–1 (*July*, 1952) *In German*

Describes a special form of screw socket for mounting standard lamps. The leads are connected directly to the contact surfaces and even with lamps taking 6 A the variation of potential drop is $< 0{\cdot}06\%$.

J. W. T. WALSH

535.241 : 628.9

6588. Quantities and units in illuminating engineering. O. Reeb. *Arch. tech. Messen, No.* 209 (*Ref. V*402–1) 123–6 (*June*, 1953) *In German.*

A logical treatment of the principal quantities used in illuminating engineering and photometry and of their units. The relations between the corresponding quantities in the study of radiation are first explained and then the photometric system is described. The final section deals with the factors in which the two sets of quantities are related. Defining equations for the various quantities are stated. J. W. T. WALSH

535.241.4 : 628.9

6589. Reduction in the number of units used in illuminating engineering and of special names for them. O. Reeb. *Lichttechnik*, **4**, 67–8 (*March*, 1952) *In German.*

A discussion of photometric nomenclature with proposals for simplification, taking the lumen as the basic unit and using the stilb-cm^2 as the unit of luminous intensity. A system of derived units and of multiples and sub-multiples is also proposed.

J. W. T. WALSH

535.242.43

6590. The effect of centring errors on the transmission of a sector disk. A. F. A. Harper and A. J. Mortlock. *Brit. J. appl. Phys.*, **4**, 220–1 (*July*, 1953).

Formulae are given for the transmission of rotating sector disks for which the edges of the sectors are not radial with respect to the centre of rotation of the disk. The cases considered include single-aperture disks for beams of various cross-sectional forms and multi-aperture disks for which the edges of the sectors are centred on the same and different points. The formulae indicate how errors due to lack of correct centring can be minimized by suitable construction of the disk. It is concluded that the errors likely to arise in practice will be negligible for all except single-aperture disks, and disks the apertures of which are not symmetrically placed about a common centre, or for the most precise work. Where significant the errors can be estimated with sufficient accuracy from the approximate formulae given. These conclusions have been confirmed by experimental test. A.

535.242.6

6591. Photometric sensitivity in steady comparison photometry of spectral lights at daylight levels. J. Schiess. *Lichttechnik*, **4**, 133–5 (*May*, 1952) *In German.*

An experimental study of the range of variation in the visual photometric measurement of spectral lights, using the step-by-step method. The measurements were made at four levels of luminance, from 10 to 10 000 asb. (π asb = 1 cd/m^2). A similar investigation was also made of the variation when spec light was compared directly with white. The lumina levels in this case were 10 and 100 asb. J. W. T. W

535.2

6592. Comparison of photometric measurements spectral lights by the flicker and equality-of-bright methods under light adaptation. J. Schiess. *Z. ang Phys.*, **4**, *No.* 10, 374–7 (1952) *In German.*

A résumé of work on the subject, previou reported by different authors, and an analysis of th results, followed by an account of an extensive se of measurements made by the author and publish in a series of papers [*Lichttechnik*, **3**, 57, 146, and 4 (1951); and preceding abstract]. Variati with field luminance are found to be very large a reproducibility is poor, especially at the ends of t spectrum. J. W. T. WAL

535.245.1 : 621.383 : 621.317.7

6593. Physical illumination photometer with phot multiplier cell. H. Schier. *Lichttechnik*, **4**, 91 (*April*, 1952) *In German.*

Describes an instrument in which the sensiti element is a photomultiplier cell with a colou correcting filter combination giving a good approx mation to the sensitivity curve of the eye. The c is housed in a box with a double window, the out covering being a dense diffusing glass and the inn covering the filter combination. The cosine err does not exceed 10% for an angle of incidence of 7C

J. W. T. WALS

535.3

6594. Optical representation of images without us of lenses or mirrors. A. C. S. van Heel. *Ingenieu* **65**, O.25–O.27 (*June* 12, 1953) *In Dutch.*

Wires, coated with a substance of lower refractive index (e.g. core 1·52, coating 1·47) bundled together and cut off at right angles at both ends, act as image transporters, giving end "images" with good contrast with high angular apertures (to at least 1 : 1·8) and with exclusion of aberrations. Such "image rods" are flexible to a high degree and have a resolving power depending on the diameter of the wires. This cannot be reduced below say 0·01 mm, as they then act as waveguides for light with the corresponding spreading of the emergent pencils in side lobes. The coating must have a thickness of at least three to five times the wavelength in order to ensure total reflection. Experiments demonstrated that the idea worked in practice, and that absorption sets the limit to the length. With hollow tubes the influence of absorption is reduced considerably, though this was not tried with small diameters. Total reflection against air with uncoated wires works well, but mounting is more difficult. Applications might lie in cystoscopy, bronchoscopy, gastroscopy and in the encoding of two-dimensional messages, such as maps, printed pages, etc. A.

535.323

6595. Refractive index determination for anisotropic crystals. A. L. Mackay. *Brit. J. appl. Phys.*, **4**, 185–6 (*June*, 1953).

Ambronn's method, matching the refractive indices of immersion liquid and crystal by rotating the plane of polarization of the incident light relative to the

stal, has been simplified by the use of a nomogram ich also enables refractive index to be related to ection in the indicatrix without calculation. A.

535.323 : 535.345

)6. Two new methods allowing the determination the index and the thickness of a thin transparent n. F. ABELÈS. *C.R. Acad. Sci.* [*Paris*] **236,** 1412–13 *pril* 8, 1953) *In French.*

It is shown how one can derive the index and the ickness of a thin transparent film deposited on a nsparent base by measuring the transmission ctor of the parallel and perpendicular polarized ams relative to an incident vibration, polarized rallel and perpendicular to the plane of incidence, e two measurements being affected at the same gle of incidence. Mathematical relations are rived so that constants can be obtained having fferent angles of incidence. The effect of errors of easurements of the values calculated are discussed. e method has been applied successfully to titanium ide layers. S. TOLANSKY

535.327

97. The change of refractive index of glycerine a function of temperature. M. CHEVALIER. *C.R. cad. Sci.* [*Paris*] **236,** 1650–2 (*April* 27, 1953) *In ench.*

The dielectric constant and the specific heat of ycerine show a discontinuity in their variation with mperature in the region marking the passage from e liquid to the solid state. Measurements of efractive index taken from −160°C to +200°C ow a similar discontinuity. R. W. FISH

535.33.03

598. Spectroscopy of the emission of organic apours excited by a high frequency field. M. VACHER ND Y. LORTIE. *C.R. Acad. Sci.* [*Paris*] **236,** 1759–61 *May* 4, 1953) *In French.*

The spectra may be those of the original molecule, r of a main constituent of the molecule, or of small ragments such as C_2, CH, NH, CO, etc.

S. T. HENDERSON

535.33.03

599. Electronically controlled spectrographic spark ource. A. BARDÓCZ. Letter in *Nature* [*London*] **71,** 1156–7 (*June* 27, 1953).

Wiring diagrams are shown for high-energy and ow-energy sources. A. G. GAYDON

535.33.03 : 537.525.8

Vacuum tube molecular emission and dissociation spectra. *See Abstr.* 6824

535.33.03 : 537.53

600. Spectroscopic study of long discharges in air. A. VASSY, H. NORINDER AND E. VASSY. *Ark. Fys.*, **5,** *Paper* 42, 437–50 (1953) *In French.*

Describes a spectrographic study of long (~1 m) impulse discharges in air at high voltages (~1 MV). Numerous spectra lines and bands were identified; the bands were faint, and the lines were due principally to O II and N II, and also to O I, N I, O III, O IV, N III and N IV. Attempts at estimating excitation temperatures were made and the results discussed.

F. LLEWELLYN JONES

535.33.03 : 541.124

The mechanism of formation of OH, CH and HCO in flame spectra, using deuterium as tracer. *See Abstr.* 7233

535.33.07

6601. The use of the minimum light criterion in spectroscopic investigations. H. MOSER AND W. SCHMIDT. *Z. Phys.*, **134,** *No.* 5, 546–53 (1953) *In German.*

By introducing a 180° phase shift by reflection into part of a beam polarized parallel to the plane of incidence, the resulting image of a slit has a sharp central minimum instead of the usual maximum. This is applied to spectroscopy by silvering part of the reflecting surface of a constant-deviation prism, thus producing spectrographs in which doublets are resolvable at one-tenth the separation required in the usual method. The precision of line separation measurements is increased 6 times. S. T. HENDERSON

535.33.07 : 535.421

6602. Compensation of astigmatic errors in a grating spectrograph. H. W. STRAAT. *J. Opt. Soc. Amer.*, **43,** 593–4 (*July*, 1953).

Discusses the correction of simple types of grating spectrographs which use a cylindrical lens between a concave grating and the slit. The inherent astigmatism of the system is investigated from the point of view of the chromatic aberration of the lens which provides the best compensation. A.

535.33.07 : 551.594.5

6603. A rapid-scanning auroral spectrometer. D. M. HUNTEN. *Canad. J. Phys.*, **31,** 681–90 (*July*, 1953).

A spectrometer is described which is capable of obtaining an auroral spectrum in 10 sec with 10 Å resolution. It uses a 4 by 4 in., 6000 lines/cm grating and parabolic mirrors for focusing. The detector is a 1P21 photomultiplier cooled by dry ice, and the spectrum is recorded by a high-speed magnetic oscillograph. The amplifiers are described and a few sample spectra shown. Some relevant optical equations are collected in an appendix. A.

535.33.07–15

6604. The construction of a double-beam infrared spectrograph. R. ZBINDEN AND E. BALDINGER. *Helv. phys. Acta*, **26,** *No.* 2, 111–28 (1953) *In German.*

Details of the instrument in which "blank" and "sample" beams alternately reach the same detector with interspersed "no radiation" periods. The signals are fed by a switch, synchronized with the chopping mirrors, to separate output stages of the amplifier and the spectrum recorded on a self-balancing potentiometer. The slit-widths are controlled to give constant "blank" energy by a servo-mechanism, and an automatically variable time constant is incorporated in the circuit so that sharp peaks can be rapidly recorded while a low noise level is maintained in the essentially transparent regions. D. H. WHIFFEN

535.33.07–15 : 537.312.5

6605. The application of lead selenide photoconductive cells to infrared spectroscopy. V. ROBERTS AND A. S. YOUNG. *J. sci. Instrum.*, **30,** 199–200 (*June*, 1953).

Lead selenide cells which, when cooled to 90°K,

are more sensitive than the best commercially available thermopiles have now been produced. The application of these cells to i.r. spectroscopy has been studied, and examples of typical spectra recorded at low and high speeds are given. A.

535.33.07–31

6606. An apparatus for the ultra-violet spectroscopy of solutions at low temperatures. R. Passerini and I. G. Ross. *J. sci. Instrum.*, **30**, 274–6 (*Aug.*, 1953).

A combined Dewar vessel and double absorption cell is described for use in the quantitative measurement of the ultra-violet absorption spectra of solutions between +100 and −196°C. The apparatus is particularly convenient when used in conjunction with the Cary recording spectrophotometer. Temperature contraction data are given for a number of useful solvents. A.

535.331

6607. Hyperfine structure of the green line of mercury. F. A. Korolev. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 6, 965–6 (1953) *In Russian.*

The Hg line 5461 Å has been analysed with the aid of a Fabry–Perot multiplex étalon, with étalons of 3·2 and 32 mm thickness; the excitation voltage did not exceed 20 V. Most results obtained agree with those of Schüler and co-workers, the differences being only found in the distribution of lines and relation of intensities in the components of the zero line. F. LACHMAN

535.332

6608. Argon vacuum wave-length measurements. T. A. Littlefield and D. T. Turnbull. *Proc. Roy. Soc. A*, **218**, 577–86 (*July* 23, 1953).

The vacuum wavelengths of 84 lines of the argon spectrum in the region 3500 to 4500 Å have been measured using two reflecting echelons. Since the standard error of the most favourable lines is only ±0·0001 Å and less than ±0·0002 Å for 53 of the lines, there is some justification in expressing the wavelengths to eight significant figures. As no systematic difference between wavelengths determined with each echelon has been found, the method is independent of the particular instrument employed. A discussion of the non-linearity of dispersion is given, and it is shown that it may be assumed linear for the particular echelons used without introducing appreciable error. A.

535.338 : 523.67

Potential energy of the triatomic molecule C_3 and the origin of the 4050 Å group in cometary nuclei. *See Abstr.* 6419

535.338 : 537.523.5

6609. The transition probabilities of several C I and C II lines, measured in an alcohol stabilized arc. H. Maecker. *Z. Phys.*, **135**, *No.* 1, 13–22 (1953) *In German.*

The water stabilized arc [see, for example, Abstr. 1820 (1952)], with alcohol, can be used to measure certain carbon line intensities. Then, if the (excitation) temperature of the discharge may be found in an independent manner, for example by a study of the simple atomic hydrogen spectra (series limit continuum, etc.), the transition probabilities of the carbon lines may be calculated. The results, with spectra, are given in the paper in some detail. for 8 C I lines and 3 C II lines are given. J. D. CF

535.33

6610. The fine structure of the $4d^3\Sigma$, $^3\Pi_{cd}$, $^3\Delta_d$ + $^3\Pi_{cd}$ transitions of the H_2 spectrum. E. W. Fo and O. Richardson. *Proc. Roy. Soc. A*, **217**, 43 (*May* 21, 1953).

See Abstr. 818 (1947). According to the class tion most of these lines, the stronger of which are resolved or partly resolved with a Fabry–Perot i ferometer, are blended. After allowing for bl and making a few changes in classification structures of the "regular" lines (ending on $2p$ states) are in general agreement with those repo earlier for the corresponding $3d^3\Sigma$, Π, $\Delta \rightarrow 2p^3\Pi$ li For the "irregular" lines (ending on $2p^3\Pi_d$ states) overall splittings are similar to those reported ear except at $K = 1$, where they differ considerably agree with more recent work on the $3d^3\Sigma$, Π, $\Delta \rightarrow 2$ lines.

535.338.

6611. Hyperfine structures of the resonance lines indium (In^{115}). G. V. Deverall, K. W. Meissn and G. J. Zissis. *Phys. Rev.*, **91**, 297–8 (*July* 1953).

In the process of developing an atomic beam li source for use at high oven temperatures an inve gation of the indium resonance lines at 4511 Å a 4101 Å was carried out. The employment of a w collimated atomic beam, excited by electron impa and of a Fabry–Perot interferometer made it possi to resolve clearly all components of the hyperfi structures of both lines. The complete resolution the line 4511 Å has not been accomplished with oth light sources by other investigators. The hig spectroscopic accuracy led to values of the hyperfi splittings of the 5 $^2P_{\frac{1}{2},\frac{3}{2}}$ terms which agree with ±0·0004 cm^{-1} with the values obtained by micr wave methods. Furthermore, a precise value for th hyperfine splitting of the 6 $^2S_{\frac{1}{2}}$ term was obtaine namely 0·2814 ± 0·0005 cm^{-1}. A

535.338.33

6612. Relative optical collision diameters from th pressure broadening of individual infrared absorptio lines. W. Benesch and T. Elder. *Phys. Rev.*, **91** 308–12 (*July* 15, 1953).

A matching method for the study of the width of individual infrared absorption lines is used t obtain relative values of optical collision diameters and to determine qualitative features of molecula interactions in pressure broadening phenomena. Isolated vibration-rotation lines of HCl and CH_4 are successively broadened by the same fourteen gases, and collision diameters derived are compared with each other and with previously published values of optical collision diameters. Striking correlations are found between the HCl relative diameters and absolute values of optical collision diameters obtained by other investigators using microwave techniques on the inversion spectrum of NH_3. The experimental data here presented are consistent with the presence of a pressure broadening interaction between the induced dipole of a broadener molecule and some undefined property of the absorber, for any broadener

ed. An additional interaction between the quadpole moment of the broadener and the dipole of the sorber appears to exist when unsymmetrical olecules are employed to broaden the spectral lines polar absorbers. A.

535.338.4

13. New observations on the band spectra of MnH d MnD. T. E. NEVIN AND D. V. STEPHENS. *Proc. oy. Irish Acad. A*, **55**, *No.* 7, 109–16 (*Feb.*, 1953).

Describes the band spectrum of MnD, and compares it with that of MnH. A new complex band stem of MnH and MnD has been observed in the frared extending from 8750 Å to about 7000 Å. dditional vibration transitions of the $^7\Pi \rightarrow {}^7\Sigma$ stem have been noted, and a new band in the violet as been observed, starting at 4160 Å in MnH and 200 Å in MnD, and degraded to longer wavelengths. D. L. EDWARDS

535.338.4

514. The $^2\Sigma^+ - {}^2\Pi_i$ band system of HBr^+. F. BARROW AND A. D. CAUNT. *Proc. Phys. Soc. ondon] A*, **66**, 617–22 (*July*, 1953).

Rotational analyses of the 1, 1 and 0, 1 bands of the $^2\Sigma^+ - {}^2\Pi_i$ system of HBr^+ have been made from pectrograms of moderate dispersion. The value of $G''_{1/2}$ is found to be 2348·3 cm^{-1}. Estimates of the quilibrium vibrational constants for the ground tate are: $\omega''_e \sim 2450$, $x''_e\omega''_e \sim 50$ cm^{-1}. A.

535.338.4

615. Band intensities in the CN violet system. M. E. PILLOW. *Proc. Phys. Soc.* [*London*] *A*, **66**, 37–9 (*Aug.*, 1953).

Relative intensities for the bands of the CN violet ystem are calculated, and compared graphically with he experimental values of Ornstein and Brinkman, nd of Tawde. A.

535.338.4

616. The visible emission spectrum of Cl_2^+. H. G. HOWELL. *Proc. Phys. Soc.* [*London*] *A*, **66**, 759–64 *Aug.*, 1953).

The vibrational analysis of the spectrum of Cl_2^+ proposed by Elliott and Cameron is criticized. The magnitude of the vibrational and electronic constants o be expected from considerations of the electron onfigurations is discussed, and it is shown that these re probably such as to make any analysis extremely ifficult. A.

535.338.4 : 523.67

New vibrational transition probabilities for the C_2 Swan bands. *See Abstr.* 6410

535.338.4 : 523.67

Calculated band intensities; Swan C_2 bands. *See Abstr.* 6411–12

535.338.4 : 523.67

Study of band spectra of N_2^+, NO and NO^+ in the Schumann region using N^{15}. *See Abstr.* 6413

535.338.4 : 523.67

Band spectrum of CO^+. *See Abstr.* 6414

535.338.4 : 523.67

A new spectrum attributed to C_2H_x. *See Abstr.* 6417

535.338.4 : 551.593.9

Active nitrogen afterglow. *See Abstr.* 6334

535.343

6617. High-dispersion study of O_3 bands at 9 μ, 4·75 μ, 3·59 μ, and 3·27 μ. Equivalent widths of ozone bands at 9·6 μ, 4·75 μ, and 3·27 μ. E. VIGROUX, M. MIGEOTTE AND L. NEVEN. Letters in *Physica*, **19**, 140–2, 143–4 (*Jan.–Feb.*, 1953) *In French.*

Tabulated wave-numbers of individual lines in the 4·75 μ band, and equivalent widths in Å for three of the observed i.r. bands, are based on measures of high-dispersion laboratory spectra obtained at the Jungfraujoch station, 1950–51. Between 9·35 μ and 8·57 μ, 200 lines have been identified, and from 4·86 μ to 4·67 μ, 110 lines, all due to O_3. The measures at 4·75 μ and 3·27 μ are corrected for superimposed H_2O lines. D. R. BARBER

535.343 : 539.133

6618. The vibrational spectra and structure of ferrocene and ruthenocene. E. R. LIPPINCOTT AND R. D. NELSON. Letter in *J. chem. Phys.*, **21**, 1307–8 (*July*, 1953).

535.343–15

6619. Study of the infrared spectrum of dicyclohexyl. J. GARACH. *C.R. Acad. Sci.* [*Paris*] **236**, 1414–16 (*April* 8, 1953) *In French.*

The spectrum is taken from 3 μ to 15 μ: the bands are compared with those of cyclohexane. Most bands are shifted slightly, but a few occur which are not found in C_6H_{12}, and which can serve to distinguish the two compounds. A. J. TAYLOR

535.343–15

6620. The infrared spectrum of CF_3D. S. R. POLO AND M. K. WILSON. *J. chem. Phys.*, **21**, 1129–31 (*July*, 1953).

CF_3D was prepared in high purity and its infrared spectrum investigated. The fundamental frequencies are: $\nu_1(a_1) = 2257$ cm^{-1}, $\nu_2(a_1) = 1111$ cm^{-1}, $\nu_3(a_1) = 693$ cm^{-1}, $\nu_4(e) = 1210$ cm^{-1}, $\nu_5(e) = 977$ cm^{-1}, $\nu_6(e) = 502$ cm^{-1}. Thermodynamic functions have been calculated with the usual assumptions. A.

535.343–15 : 535.375.5

6621. The vibrational spectra of pyridine and pyridine-d_5. L. CORRSIN, B. J. FAX AND R. C. LORD. *J. chem. Phys.*, **21**, 1170–6 (*July*, 1953).

Pyridine-d_5 has been prepared by exchange between pyridine vapour and heavy water in the presence of a palladium catalyst. Infrared and Raman spectra are reported for pyridine and pyridine-d_5 over the spectral range 300–4000 cm^{-1}. Interpretation of the spectra with the help of the product rule and by analogy with the fundamental frequencies of benzene and benzene-d_6 leads to complete sets of frequencies for the 27 vibrational degrees of freedom of pyridine and of pyridine-d_5. The frequency assignment for pyridine does not differ greatly from previous ones, but is believed to be more reliable because of the additional spectroscopic data. A.

535.343–15 : 539.13

6622. Infrared absorption of N_2 and O_2 induced by intermolecular forces. R. COULON, B. OKSENGORN, S. ROBIN AND B. VODAR. Letter in *J. Phys. Radium*, **14**, 274–5 (*April*, 1953) *In French.*

If the more usual $\log_e I_0/I$ is used in ε in Abstr. 5386 (1953) instead of $\log_{10} I_0/I$, the agreement with previous measurements at lower pressures improves. C. TURNER

535.343–15 : 539.132

6623. Note on the vibrational spectra of $SiHCl_3$, SiH_2Cl_2 and SiH_2Br_2. J. A. HAWKINS, S. R. POLO AND M. K. WILSON. Letter in *J. chem. Phys.*, **21**, 1122 (*June*, 1953).

The spectrum of $SiHCl_3$ from 450–700 cm^{-1} was taken in a 10 cm cell at pressures from <1 up to 400 mm. The observed frequencies agree well with Raman data on the liquid. The band at 810 cm^{-1} previously assigned to SiH_2Cl_2 is found to belong to $SiHCl_3$. In SiH_2Cl_2 the absorption near 610 cm^{-1} is the fundamental ν_7 (rocking). It is suggested that in SiH_2Br_2 the line at 688 cm^{-1} corresponds to the torsional vibration ν_5 and not to ν_7 as suggested by others. A. J. TAYLOR

535.343.2

6624. The excited electronic state of the 2600 Å transition in benzene. A. C. ALBRECHT AND W. T. SIMPSON. Letter in *J. chem. Phys.*, **21**, 940 (*May*, 1953).

It is experimentally confirmed that the first excited electronic state of benzene belongs to the symmetry species B_{2u} as previously found by MU and VB methods. Spectra were taken of para di-substituted benzenes, of which the state corresponding to the 2600 Å of benzene belongs to B_{3u}, which is shown by considerations of orientations of the molecules in the crystal. The symmetry groups of benzene and para-disubstituted benzene being D_{6h} and V_h respectively, a state of B_{3u} in the latter can only correspond to B_{2u} in the former molecule (benzene). A. J. TAYLOR

535.343.2 : 548.7

6625. The splitting of Pr^{+++} terms and the symmetry of the crystal field in trigonal single crystals of praseodymium salts. A.-M. HELLWEGE AND K.-H. HELLWEGE. *Z. Phys.*, **135**, *No.* 1, 92–100 (1953) *In German.*

[See Abstr. 1516 (1953)]. If the temperature at which the spectrum is taken is lowered from 58°K to 14°K, a line of the $^3H_7$–$^3P_2$ transition is resolved into a double line, although there is no change in any of the other line groups. From this the complete structure of the band and the matrix elements of the trigonal crystal field could now be determined. The symmetry of the field is found to be C_{3v}. The quantum numbers of the electronic states were determined. The use of perturbation theory shows that the crystal field approximates closer to the octahedral than to the axial symmetric limiting case. The probable ion-positions in the cell are indicated.

A. J. TAYLOR

535.343.2–15

6626. Infrared absorption of solid N_2O_5. R. TERANISHI AND J. C. DECIUS. Letter in *J. chem. Phys.*, **21**, 1116 (*June*, 1953).

Observed frequencies are assigned to NO_2^+ and NO_3^- vibrations. Certain split or broad bands are attributed either to interaction with vibrations pertaining to the opposite ion or to interaction with lattice modes. H. H. GREENWOOD

535.343.2–15 : 539.13

6627. The infra-red spectrum and structure of α- and β-hexabromcyclohexane. R. ZBINDEN. *Helv. phys. Acta*, **26**, *No.* 2, 129–44 (1953) *In German.*

The spectra of the solids of both forms are given and the data on the α form is extended to cover dip moments, steric hindrance, single-crystal spectra v polarized radiation, etc., which together prove t the α form has the same stereochemical arrangem as α-hexachlorcyclohexane. D. H. WHIFF

535.343.32-2

6628. The absorption spectrum of methaemog binazide in the 2300 to 12 000 Å region. R. HAVEMA AND W. RAUSCH. *Z. phys. Chem.*, **201**, 68–74 (*Nc* 1952) *In German.*

Solutions of methaemoglobinazide (1) buffered pH = 6·6 are measured. Values of specific extincti coefficient are tabulated and graphed by comparis with published values of methaemglobin. (1) sho characteristic peaks at 5720 and 6280 Å. G. F. LOTHI

535.343.32–

6629. Specific influence of solvents on the infrar spectra of alcohols. A. V. STUART. Letter in *J. cher Phys.*, **21**, 1115 (*June*, 1953).

The spectrum of the OH stretching frequency propanol-1 in three polar and three non-polar solven is presented. Hydrogen bonding is studied in term of the intensities and frequency shifts of the monome and association bands. The various small irregula features suggest that in detail the hydrogen bondin may be dependent upon the local conditions in th solvent in the neighbourhood of the bond.

H. H. GREENWOOD

535.343.32–3

6630. Ultraviolet absorption spectra of derivative of symmetric triazine. I. Amino triazines. R. C. HIR AND D. J. SALLEY. *J. chem. Phys.*, **21**, 1181–4 (*Jul* 1953).

The near u.v. solution spectra of 21 mono-, di- and tri-amino derivatives of symmetric triazine are reported. The addition of amino groups to the *s*-triazine ring introduces electrons which can interact with those of the ring, with resultant changes in the intensity and position of the absorption bands. The spectra of mono-, di-, tri-amino-*s*-triazine may be arranged in a Platt sequence along with that of tri-chloro-*s*-triazine and that expected for *s*-triazine. A.

535.343.4

6631. Intensity distribution among bands of the Herzberg system of O_2. M. E. PILLOW. *Proc. Phys. Soc.* [*London*] *A*, **66**, 733–6 (*Aug.*, 1953).

Using Herzberg's revised measurements [Abstr. 8067 (1952)], relative band-intensities in the system are calculated, first in absorption, and compared qualitatively with laboratory observations, and then in emission, when they are compared with Barbier's measurements on the emission from the night sky. A.

535.343.4–14 : 535.338.334

6632. Collision broadening of the microwave spectrum of ammonia. KRISHNAJI AND P. SWARUP. *J. sci. industr. Res.*, **12B**, 1–3 (*Jan.*, 1953).

Variation in the absorption of microwaves with pressure in ammonia has been studied at four wavelengths in the 3 cm region using an absorbing path of 1 metre. The experimental values have been compared with those calculated by the Van Vleck–Weisskopf formula for pressure broadening and found to be in fair agreement at low pressures; for

gh pressures the theoretical values fall below the perimental values. Bleaney and Loubser's em- rical relation for changes in $\bar{\nu}_0$ and $\Delta\nu/p$ with essure has also been confirmed. The absorption efficient value obtained for ammonia at atmo- heric pressure is $15{\cdot}6\times10^{-4}$ neper/cm, which rees well with Hershberger's and Smith's values. A.

535.343.4–14 : 539.133

6633. Preliminary analysis of the microwave spec- um of formic acid. G. ERLANDSSON. *Ark. Fys.*, **6**, *aper* 47, 491–5 (1953).

535.343.4–14 : 539.133

6634. Microwave spectrum of fluorobenzene. G. RLANDSSON. *Ark. Fys.*, **6**, *Paper* 45, 477–8 (1953).

Some 20 identified lines from 17 000–26 000 Mc/s ree with A 0·18967, B 0·08576 and C 0·05896 cm^{-1}. C–H is assumed 1·05 ± 0·02 Å then C–C 1·3916 ± 0020 Å and C–F 1·348 ± 0·005 Å. D. H. WHIFFEN

535.343.4–15

6635. Remark on the spectrum of He_2 in the near frared. D. CUTHBERTSON. *C.R. Acad. Sci.* [*Paris*] 6, 1757–8 (*May* 4, 1953) *In French.*

The (1,0) band of the $c^3\Sigma_g^+ - a^3\Sigma_u^+$ transition of e_2 is observed in emission for mA discharge near 00 Å. The apparent rotational temperature, 750°K xceeds the thermodynamic, 400°K. D. H. WHIFFEN

535.343.4–15

6636. Band analysis of carbon disulphide in the aseous phase, near 25 μ, with the aid of a registering ating spectrograph. A. HADNI. *C.R. Acad. Sci. 'aris*] **236**, 1761–3 (*May* 4, 1953) *In French.*

The apparatus used is described: the resolving ower was 1 cm^{-1}. The band near 25 μ is found to e more complicated than has been reported pre- ously. The frequencies are assigned: the centre of e band is at 395·8 cm^{-1}, the R and P branches at 03·2 and 389·7 cm^{-1} resp.; this does not agree well ith former reports, but these values seem to be ore reliable. A. J. TAYLOR

535.343.4–15

6637. Perturbation of the fundamental infrared nd of hydrogen chloride by nitrogen and argon, ompressed up to 1000 atm. R. COULON, B. OKSEN- ORN, S. ROBIN AND B. VODAR. *C.R. Acad. Sci. 'aris*] **236**, 1481–3 (*April* 13, 1953) *In French.*

The position of the vibration-rotation infrared and of HCl in solution depends upon the solvent. n order to investigate such effects, the influence of ases mixed with gaseous HCl was measured. The fluence of N_2 is essentially different from that of A: e rotational structure is sooner invisible with N_2; ith A at high pressures the two maxima can still distinguished, whilst with N_2 another maximum ear the forbidden Q branch replaces the P and R anches. The intensity of this maximum increases ith pressure. Such behaviour is characteristic of olecular shocks. A. J. TAYLOR

535.343.4–15 : 539.133

6638. The fundamental vibration-rotation band of drogen chloride. I. M. MILLS, H. W. THOMPSON AND R. L. WILLIAMS. *Proc. Roy. Soc. A*, **217**, 29–36 (*June* 9, 1953).

The absorption band near 3·45 μ has been re-measured using higher resolving power than previously. The wavelengths of the lines have been determined more precisely, and the isotopic splitting completely resolved. The results provide new and more satisfactory values for the rotational constants B_i and the centrifugal stretching constants D_i, and their relative values for the two isotopic species agree closely with what is to be expected for the difference in mass. The positions of the lines in the pure rotational absorption spectrum have been calculated from the derived data, and agree closely with those recently observed. The bond lengths r_e for each isotopic species $H^{35}Cl$ and $H^{37}Cl$ is found to be $1{\cdot}274_4$Å. A.

535.343.4–15

6639. The fundamental vibration-rotation band of deuterium chloride. J. PICKWORTH AND H. W. THOMPSON. *Proc. Roy. Soc. A*, **217**, 37–43 (*June* 9, 1953).

The band near 5 μ has been re-examined using much greater resolving power than previously. The isotopic splitting of the rotation lines has been completely resolved, and a greater number of lines has been measured in each of the branches forming the band. Rotational constants have been determined for the two combining states, and values have also been obtained for the centrifugal stretching constants. The relative values are in very good agreement with those to be expected for a pair of isotopic molecules with the atomic masses concerned. The new value ($1{\cdot}274_6$Å) derived for the bond length in both species of deuterium chloride agrees to a very high degree with that found in the preceding paper for the isotopic molecule hydrogen chloride. A.

535.343.4–15 : 539.155.2

An infrared isotope analyser. *See Abstr.* 7060

535.343.4–31

6640. Spectrographic absorption in the medium ultraviolet of oxygen compressed up to 1500 atmospheres. J. ROBIN AND S. ROBIN. *C.R. Acad. Sci.* [*Paris*] **236**, 2393–5 (*June* 22, 1953) *In French.*

Triplet bands of O_2 near 2700 Å lose their structure at high pressures. Structureless bands of $(O_2)_2$ in the region 3400–3800 Å show no broadening nor shift at high pressures. In both cases extinction coefficients increase more rapidly than (density)^2. G. F. LOTHIAN

535.343.4–31

6641. The ultra-violet absorption spectra of some gaseous alkali-metal halides and the dissociation energy of fluorine. R. F. BARROW AND A. D. CAUNT. *Proc. Roy. Soc. A*, **219**, 120–40 (*Aug.* 11, 1953).

Measurements of the fluctuation bands in the ultra-violet absorption spectra of NaF, KF, RbF, RbCl, RbBr, RbI, CsF, CsCl, CsBr and CsI are reported, and upper limits for the dissociation energies of the twelve K, Rb and Cs halides are deduced. Thermochemical information about these molecules is considered, and a value for the dissociation energy of fluorine, $D_{F_2} = 37{\cdot}6 \pm 3{\cdot}5$ kcal or $157{\cdot}3 \pm 14{\cdot}6$ kJ (298°K), is derived. A.

535.343.4–32

6642. Variation with temperature of the absorption of water vapour in the Schumann ultraviolet region. A. JOHANNIN-GILLES. *C.R. Acad. Sci.* [*Paris*] **236**, 1345–8 (*March* 30, 1953) *In French.*

At high temperature and at pressures up to 1·5 mm Hg a broad absorption band with various maxima is observed in this region. It does not obey the law of Beer and Lambert. At a given temperature the normal extinction coefficient decreases with increasing pressure. The absorption increases with temperature. The pressure effect might be explained by the assumption of predissociation, the temperature effect might be caused by the combination of photochemical and thermal dissociation, although other explanations are possible. A. J. TAYLOR

535.345 : 535.337

6643. The effect of added nitrogen on the absorption of light by oxygen as a function of the pressure. W. HEILPERN. *Helv. phys. Acta*, **25**, *No.* 7, 753–72 (1952) *In German.*

The extinction coefficient was measured in the region 2100 to 2400 Å at pressures between 50 and 127 kg.cm^{-2} for an O_2–N_2 mixture of the same composition as air. The influence of N_2 does not follow the Ångström law: it increases at constant pressure with increasing wavelength. Detailed results and interpolation formulae are given, and comparison is made with earlier measurements. R. F. BARROW

535.345

6644. The continuous absorption of light in alkali-metal vapours. R. W. DITCHBURN, P. J. JUTSUM AND G. V. MARR. *Proc. Roy. Soc. A*, **219**, 89–101 (*Aug.* 11, 1953).

The first section of this paper is an account of some experiments on the absorption of light in sodium vapour from the series limit at 2412 Å to about 1600 Å (an energy difference of 2·6 eV). The absorption cross-section at the limit is $11{\cdot}6 \pm 1{\cdot}2 \times 10^{-20}$ cm^2. The cross-section decreases giving a minimum of $1{\cdot}3 \pm 0{\cdot}6 \times 10^{-20}$ cm^2 at 1900 Å and then increases to 1600 Å. A theoretical calculation by Seaton based on the dipole-length formula gives good agreement with the experiments at the series limit and also correctly predicts the wavelength for the minimum, but it predicts a significantly lower absorption at the minimum. The experiments described in the first section of the paper conclude a series on the absorption of light in the alkali metals. The second section consists of a general discussion of the results of these experiments and of their relation to theoretical calculations. There is good agreement between theory and experiment except in regard to the magnitude of the absorption at the minimum. A.

535.345 : 548.7

Absorption of light by trapped electrons. *See Abstr.* 7296

535.345.1 : 535.81

6645. The transmission spectrum of thin silicate-glass films in the infrared region. V. A. FLORINSKAYA AND R. S. PECHENKINA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 1, 37–40 (1953) *In Russian.*

Lead silicate glasses (23–69% Pb) and some commercial flint and crown glasses, 1–3 μ thick, w examined in the region 7–14 μ. Absorption ba near 13 μ were found for Pb-containing glasses. the PbO content increased the maxima of the and 13 μ absorption bands were displaced towa greater wavelengths. It was found that, even glasses whose composition corresponds to a w defined compound, there exist regions with ordered arrangement of SiO_2 molecules (the band 13 μ was found for a lead-metasilicate glass). T 13 μ band vanishes when the PbO content exce 60%. The high refraction of lead glasses is discusse F. LACHM.

535.345.2 : 548

6646. Absorption bands and lines in irradiated Li C. J. DELBECQ AND P. PRINGSHEIM. *J. chem. Phys.*, 2 794–800 (*May*, 1953).

Deals with a number of phenomena observed LiF after formation of colour centres by exposu to X-rays, Van de Graaff electrons, or neutrons a not observed in other alkali halides under simil conditions. The most important of these phenome are: (1) The appearance of a new band at 222 m when the crystal is bleached with light of wavelen 254 mμ absorbed in the *F* band, and the inverse effe by subsequent irradiation with light of shorter wav lengths. (2) The production of *F* centres in a crys heated to temperatures up to at least 450°c. T higher the temperature at which the *F* centres we produced, the greater is the intensity of the band 222 mμ obtained by subsequent optical bleaching the *F* band at room temperature. (3) The appearanc of fine structure in a relatively weak band with pea at 380 mμ and of a very weak line at 523 mμ when th spectrum is recorded at the temperature of liqui nitrogen. (4) The very strong increase in the intensit of the band at 380 mμ and the line at 523 mμ b irradiation with short wavelength ultraviolet. (5) Th sharpness at low temperatures of the first line of th band at 380 mμ and the line at 523 mμ. At th temperature of liquid helium their half-widths are o the order of 1 Å. A

535.37

6647. Sensitized phosphorescence of organic mole cules at low temperature. Intermolecular transfer o energy with excitation of the triplet level. A. N TERENIN AND V. L. ERMOLAEV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 547–50 (1952) *In Russian.*

At −180°c, mixtures of benzaldehyde and naph thalene, benzophenone and naphthalene, and benzo phenone and diphenyl, when irradiated with mono chromatic light of wavelength within the absorption band for the first, but outside that for the second components named, in each case, excites phos phorescence of the latter (sensitized) component, spectrally identical with its normal light-activated phosphorescence. The intensity of the sensitized phosphorescence is directly proportional to the concn. of the sensitizer, while the emission of the latter falls as the concn. of the sensitized component increases, indicating a transfer of energy from the sensitizer to the sensitized molecule. This transfer is to triplet levels of the latter. R. C. MURRAY

535.37

6648. Decay of the luminescence of ruby. N. A. OLSTOĬ AND P. P. FEOFILOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 551–4 (1952) *In Russian.*

The period T of decay of the luminescence of ruby depends not only on the temperature and Al_2O_3 concn., but also on the spectral band studied. Excitation and decay are in all cases exponential. At 0·055% and 0·39% Cr_2O_3 contents, τ of the doublet at 6942 and 6927 Å decreases continuously with increase of temperature, but at 0·86% Cr_2O_3 and above, it passes through a max. at 200–300°K. There is a max. in the plot of τ against Cr_2O_3 concn. which, although quite flat at room temp., is so sharp at 180°C as to suggest that τ measurements might be more accurate than chemical analysis for determining the Cr_2O_3 contents of rubies. The rather complicated pattern of luminescence behaviour is evidently conditioned by interaction between the Cr^{3+} ions and processes in the Al_2O_3 lattice. R. C. MURRAY

535.37

6649. The effect of the fluorescent action of the exciting light on the yield of phosphorescence. L. I. ANIKINA. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 1, 41–4 (1953) *In Russian.*

It was established previously for rare earth phosphors that, as a result of excitation, additional absorption is produced which is proportional to the number of electrons located on the levels of capture or, which is the same, to the number of ionized centres of luminescence. The presence of this additional absorption in the short wave region of the spectrum indicates that a portion of the energy of the exciting light is used up directly in freeing electrons from the levels of capture and perhaps also in transferring electrons from the filled-in zone to the free levels of ionized centres of luminescence. This results in additional losses in the excited phosphor. It is shown that these losses can be considerable. Owing to this the yield of luminescence is considerably decreased. The yield was measured for CaS . SrS — Ce, Sm and SrS–Eu, Sm, when these were excited with a monochromatic light in the range from 250 to 500–600 mμ. The measurements were carried out under steady excitation and under non-steady excitation. It was found that under a steady excitation the yield of SrS . CaS — Ce, Sm for $\lambda = 302$ mμ, when a source of infra-red light of high intensity is connected, increases by approx. 1·5 times. E. RABKIN

535.37

6650. Decay time measurements on liquid and solid solutions with a new fluorometer. A. SCHMILLEN. *Z. Phys.*, **135**, *No.* 3, 294–308 (1953) *In German.*

The time was determined by measurement of the phase difference between the exciting light (3600 Å modulated at ~5 Mc/s) and the fluorescence emitted, using a photomultiplier, transformation of the signals to 50 c/s, and final display on a c.r. tube. Solutions of fluorescein, trypaflavine and rhodamines, if in thin layers, gave nearly constant decay times with increasing concentration up to the quenching region where a rapid fall sets in. In thicker layers there was sometimes an increase of decay time below the quenching range of concentration, due to added delay introduced by absorption and re-emission in the deeper layers of solution. When solutions of mixed dyes were excited the results varied with the absorption and emission bands involved. Solid solutions of naphthalene and its homologues were also examined, and energy transfer processes considered. The apparatus worked in the region of 3 to 100×10^{-9} sec. S. T. HENDERSON

535.37

6651. Quantitative investigations on the X-ray coloration of sensitized KBr crystals. W. MARTIENSSEN AND H. PICK. *Z. Phys.*, **135**, *No.* 3, 309–17 (1953) *In German.*

The efficiency of the action is chiefly determined by the presence of sensitizers. As an example the sensitizing of KBr by KH has been investigated quantitatively. The sensitizer provides for the production of holes as well as electrons. The electrons bound at colour centres are then very stable. Quantitative relations between colour centre concentration, intensity of radiation, time of radiation and concentration of sensitizers are obtained. The energy required to begin the photochemical reaction is in all cases 35 eV, whatever the hydride concentration or intensity of radiation. J. EWLES

535.37

6652. Fluorescence spectra and quantum yields of some solid organic substances under u.v. excitation. D. ROSAHL. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 35–44 (1953) *In German.*

The materials were excited by a high pressure Hg lamp with Wood's glass filter, and their spectra photographed on plates which were calibrated by a standard tungsten source. The curves given are for aryl substituted pyrazolines, halogen substituted triphenylpyrazoline, and dihydrocollidine dicarboxylic ethyl ester (DHC). Details of purification are given. Quantum efficiency was estimated at approximately unity for anthracene, DHC, and triphenylpyrazoline, but the halogen-containing substances generally showed lower values. S. T. HENDERSON

535.371

6653. The percentage fraction of polarization in the fluorescence of organic single crystals. S. C. GANGULY AND N. K. CHOUDHURY. *Z. Phys.*, **135**, *No.* 3, 255–9 (1953) *In German.*

Crystals of anthracene, phenanthrene, chrysene and pyrene were arranged with the *b*-axis vertical and the *c*-plane normal to the exciting light, which was a beam of filtered Hg radiation polarized with the electric vector vertical. Measurements on the polarization of the fluorescence, together with X-ray crystallographic data, lead to the conclusion that the fluorescence is completely polarized. S. T. HENDERSON

535.371

6654. The afterglow of cadmium borate. H. DZIERGWA. *Z. Phys.*, **135**, *No.* 3, 283–93 (1953) *In German.*

Using excitation by 2537 Å radiation and a phosphoroscope, decay curves were measured in different wavelength regions isolated by interference filters. Combination of pairs of these curves led to an analysis of the decay into exponential components. At −170°c the emission comprised a green band (α)

of time constant 206 sec^{-1}; an orange band (β) of time constant 45·5 sec^{-1}; and a deep red band (γ) of non-exponential character. All three bands occur in preparations of $Cd_2B_2O_5$. Mn, though the α-process is attributed to the unavoidable presence of CdB_4O_7. Mn. Each band has the same decay throughout its own spectral range. At −50°C the constant of the β-process becomes 55·5 sec^{-1}, but the γ-process is scarcely altered. S. T. HENDERSON

535.371

6655. Determination of quantum efficiency of luminescent powders by calorimetric measurement. Z. BODÓ. *Acta phys. Hungar.*, **3**, *No.* 1, 23–30 (1953).

A new method was developed for the measurement of the quantum efficiency of luminescent powders, which aimed at the calorimetric determination of the increase in temperature due to irradiation. The temperature increase is related to the same effect in non-luminescent carbon black making thereby possible the calculation of the quantum efficiency. This method was adopted for the determination of the quantum efficiency for five different substances, with an overall accuracy of approx. 3%. For willemites containing greater amounts of manganese or iron, it was established in the course of the investigation, that infrared luminescence is not emitted, the energy absorbed within the substance being converted entirely to thermal energy. A.

535.371

6656. The atomic position and size of the thallium ions in KCl(Tl) phosphors. W. A. RUNCIMAN AND E. G. STEWARD. *Proc. Phys. Soc.* [*London*] *A*, **66**, 484–91 (*May*, 1953).

A new X-ray investigation was made of the KCl(Tl) phosphor in view of the discrepancy between the early theory of Fromherz involving formation of complexes in the KCl(Tl) phosphor and the recent theoretical work of Williams, in which substitutional entry of the thallium ions is assumed. The present study has now shown (*a*) that the expansion of the potassium chloride structure due to the incorporation of thallium is in agreement with Vegard's law and (*b*) that Tl^+ ions enter the structure substitutionally. The present results differ from those obtained by Stasiw and Saur in a less detailed X-ray study. The intensities of X-ray reflections have also been used to establish the atomic position of the activator atoms in the phosphor and the results fully confirm the interpretation of the observed lattice expansions. A new value of 1·42$_7$ Å has been obtained for the ionic radius of the Tl^+ ion in six-fold co-ordination with Cl^- ions. This is of importance in the detailed calculations of the luminescence of KCl(Tl) which have been made by Williams and others. A.

535.371

6657. The phosphorescence of thoria. C. E. MANDEVILLE AND H. O. ALBRECHT. Letter in *Phys. Rev.*, **90**, 992–3 (*June* 1, 1953).

A constant intensity luminescence of ThO_2 is observed due to self-excitation by its α, β and γ-ray emission. External α excitation gives rise to rapidly decaying phosphorescence of complex form (spectral emission at 4500 Å). G. F. J. GARLICK

535.371 : 537.

The absolute scintillation efficiency of anthrace

See Abstr. 6890

535.37

6658. Fluorescence of organic single crystals at l temperatures. I. Tetraphenyl 1144 butadiene M. BARBARON AND P. PESTEIL. *C.R. Acad. S.* [*Paris*] **236**, 1763–4 (*May* 4, 1953) *In French.*

535.37

6659. The statistical interpretation of polarizati data in Raman spectra. M. C. TOBIN. Letter *J. chem. Phys.*, **21**, 1110–11 (*June*, 1953).

Illustrates the use of statistical analysis in searchi for systematic errors in measurements using differe plates or in passing from one line to another in da on the depolarization factors ρ for the five lines CCl_4. It is also shown that the mean value $\rho = 0·8$ for the four depolarized lines is not significant different from 6/7. The question of determining fro a single measurement whether a given line is polarize or depolarized is considered. H. H. GREENWOO

535.375

6660. Raman spectroscopy of low pressure gase and vapors. H. L. WELSH, M. F. CRAWFORD, T. H THOMAS AND G. R. LOVE. *Canad. J. Phys.*, **3** 577–96 (*Sept.*, 1952).

Raman spectra of gases and vapours at pressures a few atmospheres were obtained with a carefull diaphragmed Raman tube of large volume, irradiate by five high intensity mercury lamps with water cooled electrodes. Frequencies and intensity contour of 32 of the 35 fundamental bands of CH_4, CH_3Cl CH_2Cl_2, $CHCl_3$, CCl_4 and CH_3Br were measured Vibrational assignments, based on the intensity contours of the bands, showed no discrepancies in previous assignments. The integrated intensities o the bands, determined on the same intensity scale fo all compounds of the series, show the inadequacy o the bond polarizability theory of Raman intensities Depolarization factors, calculated from the intensity distribution in totally symmetric bands, are somewhat greater than those measured for the liquid. Asymmetries in the Q branches of some totally symmetric bands are explained quantitatively in terms of anharmonicity and isotope effect. A.

535.375.54

6661. An intense-light Raman powdered crystal arrangement. J. BRANDMÜLLER. *Z. angew. Phys.*, **5**, *No.* 3, 95–101 (1953) *In German.*

A high-pressure lamp is imaged on the specimen, the light first passing through 1 or 2 narrow-band interference filters with high transmission at the exciting wavelength (4358 Å). A similar filter used as a reflector in the scattered light removes most of 4358 Å but reflects freely elsewhere. With a powdered naphthalene specimen a 1 hour exposure is adequate; 15 new lines were found, but 2 lines previously reported could not be found. G. F. LOTHIAN

535.375.54

6662. New measurements on the anomalies of polarization in the Raman spectrum of calcite. L. COUTURE-MATHIEU AND J.-P. MATHIEU. *C.R. Acad. Sci.* [*Paris*] **236**, 1868–70 (*May* 11, 1953) *In French.*

The intensity of radiation scattered transversally by

crystal of calcite has been measured for various orientations of the optical axis of the crystal.

G. I. W. LLEWELYN

535.375.54 : 548

6663. Considerations on the Raman spectrum provided by the water in hydrated crystals. J. CHAPELLE AND A. GALY. *C.R. Acad. Sci.* [*Paris*] **236,** 1653–5 (*April* 27, 1953) *In French.*

A mathematical discussion is given of the elements of symmetry of water molecules present in crystals.

G. I. W. LLEWELYN

535.375.56

6664. The ν_3 Raman band of ammonia. C. CUMMING AND H. L. WELSH. Letter in *J. chem. Phys.*, **21,** 119–20 (*June*, 1953).

The ν_3 vibration, corresponding to the doubly degenerate N–H bond stretching, is in infrared strongly overlaid by ν_1, and has not been observed previously in the Raman spectrum of the gas, whilst in the liquid phase the band is much disturbed. The rotational structure is complex for this type of band. The Raman spectrum was taken, and 37 maxima could be attributed to ν_3. The band was analysed and values for the vibration frequency ($\nu_0 = 3444\ \text{cm}^{-1}$) as well as for the rotational constants were found, the latter with the use of data from the rotational Raman spectrum at high dispersion. A. J. TAYLOR

535.376

6665. Decay of long period afterglow of alkali halides under cathode ray excitation. H. N. BOSE AND J. SHARMA. *Proc. Phys. Soc.* [*London*] *B*, **66,** 371–6 (*May*, 1953).

The long period afterglow of pure and activated alkali halides excited with cathode rays was studied at room and liquid oxygen temperatures. It has been found that the decay follows a power law $I \propto t^{-n}$ between 10 and 100 sec. The value of the power constant n lies in general between 0·7 and 1·1 and is dependent on the exciting intensity. The decay rates are different for different parts of the spectrum. An attempt has been made to explain the results by an extension of the existing theory developed for photoluminescence. A.

535.376 : 537.226.2

6666. Dielectric changes of electroluminescent phosphor during illumination. S. ROBERTS. *J. Opt. Soc. Amer.*, **43,** 590–2 (*July*, 1953).

Phosphor powder was incorporated in a thin film of plasticized polyvinyl chloride. The dielectric constant and loss of the film was measured at 1000 c/s under various intensities of illumination and at different applied voltages. White light from a tungsten lamp was used for some experiments, while others were done with monochromatic light of different wavelengths from a mercury arc. The results of these experiments show a very substantial variation of dielectric constant under illumination. Further, the magnitude of the change of dielectric constant depends critically on the value of the voltage applied during the tests. There is a maximum effect at about 4046 Å, while the sensitivity falls off noticeably at 3650 Å and 4358 Å. A.

535.376 : 621.383 : 621.317.32.082.5

6667. Transient voltage indicator and information display panel. A. BRAMLEY AND J. E. ROSENTHAL. *Rev. sci. Instrum.*, **24,** 471–2 (*June*, 1953).

Applications of a semiconductor electroluminescent panel [Abstr. 156 (1953)] are discussed. Photoelectric measurements of the intensity of luminescence serve to measure the applied voltage. If the panel is combined with a layer of a photoconductor (e.g. Tl_2S), storage effects in the latter can be used for the display of transient voltages. Large area panels with grid electrodes can be used to display information.

D. G. AVERY

535.377 : 549 : 535.343.548.7

Coloration and luminescence (contribution to mineral physics). *See Abstr.* 7295

535.39

6668. Measurement of the index of refraction of thin absorbing layers under normal incidence. Application to carbon. F. LESQUIBE AND P. GIACOMO. *J. Phys. Radium*, **14,** 4*S*–5*S* (*April*, 1953) *In French.*

Using a method previously described [Abstr. 7903 (1950)], together with a refinement in the technique of measuring the phase change due to reflection [Abstr. 5692 (1952)], the authors determined n and k (5460 Å) for carbon films prepared *in vacuo*. Control experiments based on measurements at carbon-glass and carbon-air surfaces give results differing considerably: this is interpreted as due to some heterogeneity caused by the absorption of gases. R. A. WEALE

535.412

6669. Influence of the wavelength on the sharpness and brilliance of the maxima of the rings formed by a semi-silvered Fabry–Perot etalon. J. ROIG AND E. COLLET. *C.R. Acad. Sci.* [*Paris*] **236,** 1866–8 (*May* 11, 1953) *In French.*

Measurements are reported for fringe sharpness and intensity. Although internally consistent, the absorptions for Ag films appear to be higher than those of other investigators. This is attributed to insufficient pumping speed. Data are reported for eight wavelengths over the range $\lambda\lambda$4500–6800. Some results for Al films are briefly indicated. S. TOLANSKY

535.414

6670. Observations on the optical measurement of thickness with three-beam interference. K. STROHMAIER. *Z. Phys.*, **135,** *No.* 1, 44–9 (1953) *In German.*

Attention is drawn to a possible source of error when using the three-slit method advocated by Zernike [Abstr. 6402 (1950)] for the measurement of small optical thickness. It is shown by measurement that an error arises when the triple slit is not projected parallel on to the principal plane of the objective lens. A treatment is carried out for the various cases which may arise in practice and the percentage errors resulting are evaluated. S. TOLANSKY

535.417

6671. The poles of the *S*-matrix of an interference filter. D. C. FRAU. *An. Acad. Brasil. Ciênc.*, **25,** *No.* 1, 61–3 (1953) *In French.*

A theory is developed applicable to multilayer interference filters. The solution can only be carried through for special cases of refractive index values.

The analysis is carried through in terms of Brillouin zones. S. TOLANSKY

535.42

6672. Instrumental diffraction. II. General properties connecting pupil and diffraction pattern. III. Intensity and phase at the focus. IV. Intensity in the outer areas of the diffraction pattern. G. LANSRAUX. *Rev. Opt.*, **31**, 444–56 (*Oct.*); 545–60 (*Dec.*, 1952); **32**, 73–90 (*Feb.*, 1953) *In French.*

II. For Pt I, see Abstr. 8096 (1952). Mathematical developments are given which formally justify known physical properties, and which lead to rules or formulae of practical interest on symmetry, rotation, translation, etc. Theorems concerning the total energy of the pupil and the diffraction pattern are derived.

III. Formulae are given allowing the study of the centre of the diffraction pattern, and its determination by simple formulae in the case of small aberrations.

IV. An asymptotic expression is derived for the intensity along the radial direction of the diffraction pattern. Some general properties of amplitude filters are given and some numerical results quoted.

R. W. FISH

535.42

6673. On the resolving power of transmission echelon. M. S. SODHA. Letter in *Sci. and Culture*, **18**, 489 (*April*, 1953).

A formula is derived, taking into account the effect of absorption of the material. This reduces the intensity of beams from the longer paths, which leads to reduction in fringe resolution. S. TOLANSKY

535.42 : 548.735

The application of the principles of physical optics to crystal-structure determination. *See Abstr.* 7316

535.421

6674. The study of diffraction grating characteristics by simplified phase contrast methods. E. INGELSTAM AND E. DJURLE. *J. Opt. Soc. Amer.*, **43**, 572–80 (*July*, 1953).

The simple accessories required for studying spectroscopic apparatus, especially diffraction gratings, by this method may be mounted directly on existing instruments. The accessories are phase mirror, lens and receiving unit. The examination is made using light from a strong spectral line. The receiving unit may be the eye, a photographic plate, or a photoelectric scanner. The results are interpreted in some detail. It is shown that a true phase curve of the wave front is obtained in so far as it is due to periodic structures inherent in the grating, so that the information is quantitative and accurate to better than $\lambda/300$. Random defects, important because they give rise to stray light, are revealed with less precision. As a result of the calculations, recommendations are made for the dimensions of accessories to suit different grating types. Examples of structures are shown. A.

535.421

6675. On the preparation of plane diffraction grating replicas from helical rulings. G. D. DEW. *J. sci. Instrum.*, **30**, 229–32 (*July*, 1953).

A method of preparing plane diffraction grating replicas from helical rulings suggested by Mert[illegible] [Abstr. 3984 (1950)] and developed at the N.P.[illegible] [Abstr. 2389 (1953)] is described in further deta[illegible] Particular reference is made to the method of pr[illegible] paring the plastic "pellicle," and sources of error [illegible] this and other stages of the process are indicated.

535.43 : 537.5[illegible]

6676. The angular dependence of the scattering [illegible] light by single cloud droplets. (Measured on the track of cosmic ray mesons in a Wilson-chamber.) M. [illegible] ELSAESSER AND K. WIRTZ. *Z. angew. Phys.*, **5**, *No.* [illegible] 133–9 (1953) *In German.*

This was measured photographically for droplet[illegible] formed in a cloud chamber, containing an alcohol[illegible] water mixture. Special precautions were taken t[illegible] eliminate background scattering. The results ar[illegible] presented graphically, and compared with those o[illegible] other workers. J. HUGHE[illegible]

535.55

6677. An ethoxylene resin for photoelastic work[illegible] H. SPOONER AND L. D. MCCONNELL. *Brit. J. appl. Phys.*, **4**, 181–4 (*June*, 1953).

The material, Araldite casting resin type B, has a higher figure of merit than any other presently in use for three-dimensional analysis. It can be readily cast into large sizes, and it has admirable bonding properties. The more important properties of the material are briefly described and the opportunities it gives for increased precision in photoelastic work are discussed. Some typical examples of its use are described and the major defects of the material, namely mottle and the development of time-edge stress, are discussed. A.

535.55 : 539.31 : 539.37[illegible]

6678. Elasto-plastic stress-optical effect in silver chloride single crystals. L. E. GOODMAN AND J. G. SUTHERLAND. *J. appl. Phys.*, **24**, 577–84 (*May*, 1953).

The use of silver chloride as a material for "photoelastic" stress analysis offers the possibilities of studying both elastic and plastic states of stress in a crystalline material on either a micro- or macroscale. It is necessary, however, to relate quantitatively the stress state and the observed relative retardation and extinction angle. In this paper these relationships are developed from a general theory of stress birefringence, according to a stress-dependent hypothesis. This hypothesis and the resulting analytical relationships are experimentally vindicated by measurements made on a variety of single crystal specimens of silver chloride tested in simple tension in the elastic and plastic stress ranges. A.

535.6 : 535.89

6679. Specification of color-rendering properties of fluorescent lamps. C. W. JEROME AND D. B. JUDD. *Illum. Engng*, **48**, 259–67 (*May*, 1953).

A discussion of the problem of expressing the colour-rendering properties of fluorescent lamps in a simple form, followed by a critical examination of the spectral band method. Three different sets of bands were used to express the properties of eight lamps and it was found that the set of eight bands put forward by the C.I.E. [see Abstr. 1790 (1951)] was at least as good as the others. It is recommended that these bands be used, at least for the present, and that if a single

dex is required it should be the average difference etween test lamp and standard (a Planckian radiator) s determined for each of the eight bands, differences eing expressed as percentages of radiant energy.

J. W. T. WALSH

535.642

6680. Additivity of colour equations. P. W. REZONA. *Proc. Phys. Soc.* [*London*] *B*, **66**, 548–56 (*July*, 1953).

A colour can be matched by an additive mixture of hree coloured lights, the most suitable being specified ed, green and blue stimuli. If c_1 units of one colour re matched by r_1, g_1 and b_1 units of red, green and blue respectively, and c_2 units of another colour by r_2, g_2 and b_2 units, then according to the law of additivity of colour equations the combined colour may be matched by $r_1 + r_2$, $g_1 + g_2$ and $b_1 + b_2$ units respectively. It is the purpose of this work to investigate this law. Additivity of colour equations is implicit in all colorimetric calculations. The law is based on the results of early work done with the comparatively crude apparatus of the time, but recently these results have been questioned. The experimental work was performed on the Wright colorimeter, where colour matches were made on pairs of stimuli separately and in combination. The results showed some deviations from additivity, but on the whole these were small. Large deviations appear to be associated with poor discrimination. A.

535.65

6681. Subtractive method of colorimetry with the Pulfrich photometer. L. FRIEDRICH. *Z. wiss. Photogr.*, **48**, *No.* 4–6, 65–84 (1953) *In German.*

E. Hellmig stated the principle that any colour which can be obtained with a ternary mixture can be divided into a neutral and a binary subtractive mixture provided the three components used will give a neutral [see Abstr. 1616–17 (1949)]. The author examines the possibility of colorimetry on this principle, using the Pulfrich photometer with a set of three wedges of the Agfacolor positive dyes. The method is described and its accuracy is shown by the results obtained on a series of 10 test colours. It is concluded that the method is practical and worth developing.

J. W. T. WALSH

535.65

6682. Automatic calculation of color differences. A. OPLER, R. W. MEIKLE AND M. J. CHARLESWORTH. *J. Opt. Soc. Amer.*, **43**, 550–1 (*July*, 1953).

Punched-card operated computing machines have been used to translate from C.I.E. space to the equal visual stimulus space of Adams. Differences in terms of Judd units are calculated by the machines as are the original colorimetric integrations. These methods have been used to process several thousand routine reductions of spectrophotometric data and their conversion to Adams space. A.

535.65

6683. The size of acceptable color differences. H. R. DAVIDSON AND E. FRIEDE. *J. Opt. Soc. Amer.*, **43**, 581–9 (*July*, 1953).

In order to determine the size of acceptable colour differences for a particular production problem, about 12 000 individual judgments of the acceptability of 287 samples as matches with 19 standards were made. The samples represented colours in all sections of the colour domain, and the samples represented various size colour differences from the standards. Colorimetric measurements of the samples were made and the colour differences were calculated according to the several methods currently in use. Colour differences were then plotted against the visual judgments of acceptability. Calculations based on rather small modifications of the MacAdam ellipses were found to correlate with the visual results much better than do those based on other methods. It was found that colour differences falling within an ellipsoid about 2½ times the size of those published by MacAdam with a radius vector of about 0·15 Munsell value unit parallel to the Y axis were accepted in 50% of the observations. A.

535.65

6684. Truncated weighted ordinate integrations in colorimetry. D. L. MACADAM. Letter in *J. Opt. Soc. Amer.*, **43**, 622–3 (*July*, 1953).

Colour mixture data are tabulated from 380 to 770 mμ, but many spectrophotometers are limited to between 400 and 700 mμ. The "tails" are often ignored, but the error made in this way can be reduced by assuming that they are either linear or parabolic in form and adjusting the data at 400, 410 and 420 and at 680, 690 and 700 mμ accordingly. A combination of linear and parabolic extrapolations is suggested as having advantages in computation.

J. W. T. WALSH

535.7 : 612.84

Physiological optics. *See Abstr.* 7373–7

535.822.9

6685. A method of beats and a method of rectification [detection] allowing objects to be revealed of a smaller size than the normal limit of resolving power. A. BLANC-LAPIERRE, M. PERROT AND G. PERI. *C.R. Acad. Sci.* [*Paris*] **236**, 1540–2 (*April* 20, 1953) *In French.*

The relationship between an object and its image formed by a diffracting pupil can be readily expressed by means of a linear filter acting upon the waves comprising the object. The wave pattern in the image region may sometimes be rendered visible (*a*) by a change of frequency obtained by superimposing a second set of waves or (*b*) by rectification, i.e. a non-linear transformation. Practical methods are described illustrating both possibilities and sample results are shown. R. W. FISH

535.822.9 : 535.41

6686. Interference microscope using a plate of spar cut perpendicular to the axis. M. FRANÇON. *An. Acad. Brasil. Ciênc.*, **25**, *No.* 1, 47–52 (1953) *In French.*

An apparatus is described for use in front of an ordinary microscope objective, even an immersion objective, yielding an interference microscope with an annular source. The variations in optical path show as variations in intensity or colour. R. W. FISH

535.88

6687. The optical projection of the profile of an article at a given cross-section. G. F. MORTON AND V. E. GOUGH. *J. sci. Instrum.*, **30**, 277–80 (*Aug.*, 1953).

Two types of projector are described which permit the continuous observation of the sectional shape of a rod-like or thread-like object, of substantially constant cross-sectional shape, as the object is passed through the projector. The article may be of any length and may be flexible or rigid. The projection of sectional shape may be accomplished by two distinct methods. The first employs the projection of light scattered from the surface of an illuminated peripheral band of the object. In the second method the object is placed co-axial with a projection lens which receives scattered light from all points on the surface of the object under examination. The lens selects a thin section of the object and projects the peripheral shape of this section on to a screen. The application of these projectors to the continuous gauging of the outside dimensions of rubber tubing is described. A.

535.88 : 621.326.73

6688. Projector lamp and useful light flux in projector. J. RIECK. *Lichttechnik*, **4**, 237–9 (*Sept.*, 1952) *In German.*

Examines the possibility of rating the performance of a projector in terms of the useful luminous flux from the lamp and concludes that this is possible, within limits of $\pm 12\%$ so long as the lamps used are those of one maker. J. W. T. WALSH (R)

535.89 : 537.523.5 : 537.53

6689. The carbon arc as an infrared source. J. H. JAFFE. Letter in *J. Opt. Soc. Amer.*, **43**, 619 (*July*, 1953).

A note describing improvements in carbon arc techniques for work in the rocksalt infrared. The apparatus consists of a 7 A (constant current) arc between 6 mm electrodes with a clockwork feed. Satisfactory stability is obtained. J. D. CRAGGS

535.89 : 537.542

6690. Investigation of a flash tube for illuminating a Wilson chamber. B. MEYER. *Z. angew. Phys.*, **5**, *No.* 4, 139–42 (1953) *In German.*

The luminous efficiency was measured for energies up to 5000 watt-secs and potentials up to 30 kV. The relative total light intensity was measured photographically using the grey wedge method. The luminous efficiency (lumen-sec/watt-sec) increases with increasing energy, but is only slightly dependent on the electrical potential. The construction of a flash tube is briefly described. J. HUGHES

535.89 : 778.37

6691. A simple low-frequency double-flash stroboscope. J. E. CAFFYN AND R. M. UNDERWOOD. *J. sci. Instrum.*, **30**, 257–9 (*Aug.*, 1953).

A double-flash stroboscope has been built using two Siemens SF6 flash discharge tubes. These are powered from two separate variable d.c. sources (0–4000 V) and are controlled electronically. Two-pulse generators of the "inductive kicker" type initiate the discharge in the flash tubes and are in turn controlled by a multivibrator. The latter governs the repetition frequency (2–50 c/s) and the time interval between the double flash (0·5–20·0 msec).

HEAT 536

536.

6692. The unit dimensionally consistent with temperature. F. AVČIN. *Rev. Sci.* [*Paris*] **90**, 235– (*July–Aug.*, 1952) *In French.*

It is argued that temperature is a derived mechanical quantity and should be incorporated in the Giorgi system. Details of the method of achieving this using statistical mechanics and the equation of state of a perfect gas, are given. The dimensions of temperature are $[ML^2T^{-2}]/[M_0]$ where M_0 is the ratio of the mass of a mole to that of a molecule, and the coherent Giorgi unit is 1 joule/1 mole. S. WEINTROUB

536.1 : 536.42 : 536.7

6693. On the pseudo-adiabatic transformations of open gaseous systems. P. JACOBS. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 1. 94–104 (1953) *In French.*

The classical laws relating to adiabatic transformations in perfect gases are extended to the case of pseudo-adiabatic changes in open systems consisting of one or several perfect gases or a saturated vapour in a perfect gas phase. As an application the problem of measurement of flow by compression into a closed container is considered. The work may be considered as an extension of that of van Lerberche and Glansdorff on the laws of humid gases and open systems. F. E. HOARE

536.2

6694. A certain problem in heat conduction. H. ZATKIS. *J. appl. Phys.*, **24**, 895–6 (*July*, 1953).

A homogeneous sphere is surrounded by an infinite homogeneous medium. Heat is generated inside the sphere at a prescribed rate. The temperature distribution inside and outside the sphere is computed. A.

536.2.01 : 523.36

6695. Conduction of heat in a solid with periodic boundary conditions, with an application to the surface temperature of the moon. J. C. JAEGER. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 2, 355–9 (1953).

Theoretical. It is shown that if the surface temp. θ of a semi-infinite solid (density ρ, sp. ht. c and thermal conductivity k) is a periodic step-function having the values $\theta_1\theta_2 \ldots \theta_N$ in the intervals $t = 0$ to $(TN)^{-1}$, $(TN)^{-1}$ to $2(TN)^{-1}$, etc., then the average surface flux of heat (F_n) into the solid in the interval $n - 1/NT$ to n/NT is given by $F_n = \left(\frac{k\rho c}{\pi T}\right)^{\frac{1}{2}} \sum_{s=1}^{N} \theta_s \Phi_{n-s+1}$ where Φ_n are numerical coefficients depending on N. Values of Φ_n are tabulated for $N = 20$: comparison with the exact solution for sinusoidal variation of θ shows the errors in amplitude and phase of the surface flux to be 2% and 1% respectively. The surface flux being defined in this way, any boundary conditions relating F and θ can be written in the form of N algebraic equations soluble for θ_1 to θ_N. Application of this method to calculation of the lunar surface temperature variation gives agreement with exptl.

servation when $(k\rho c)^{\frac{1}{2}}$ is in the range 250–1000, a lue appropriate to cellular material or fine dust der lunar conditions. A. SCHOFIELD

536.2.08

96. On the measurement of the thermal conctivity of liquids by a non-stationary method. F. M. VAN DER HELD, J. HARDEBOL AND J. KALOVEN. *Physica*, **19**, 208–16 (*March*, 1953).

The method of Abstr. 1699 (1950) was found to be reliable. The time during which convection does t disturb the measurements appeared to be too ort to apply the proposed mathematical approximaons. E.g. neglecting the ratio of the specific heats r cm³ of the liquid and the heating wire $(c\rho/c_0\rho_0)$ nnot be allowed. In consequence of a more rigorous athematical treatment the method has been changed yield the correct results as its application to a ries of experimental data shows. As the necessary anges mean a serious drawback of the original ethod it is suggested to lengthen the time during ich measurements are possible by rotating the ssel containing the liquid about the heater to ppress convection. A.

536.21

97. On the conduction of heat in a homogeneous r. K. POPOFF. *C.R. Acad. Sci.* [*Paris*] **236**, 1640–1 pril 27, 1953) *In French.*

An extension of a previous note [Abstr. 5435 953)].

536.21 : 536.48 : 538.66

98. The thermal conductivity of metals in high agnetic fields at low temperatures. K. MENDELSSOHN ND H. M. ROSENBERG. *Proc. Roy. Soc. A*, **218**, 0–205 (*June* 25, 1953).

In heat conductivity measurements between 2 and 5°K twenty-seven pure metals have been subjected a magnetic field of 4 kOe. Of these, Cd, Sn, Pb, n, Ga, Ag, Tl and In show appreciable magnetosistance effects. Single crystals of Cd, Sn and Pb ere investigated, and of Zn and Ga, single crystals different orientations. Ag, Tl and In were polyystalline specimens. Transverse and longitudinal lds were applied, the effect being always greater in e transverse case. Single crystals of Zn, Sn, Cd and specimen of Tl were investigated in transverse fields to 18·5 kOe. The thermal resistance of the Cd ystal was increased by a factor of 1000 at 2·3°K, nd the use of this effect in a thermal switch has been ggested. In transverse fields the thermal resistance all metals was found to rise linearly except for very nall fields. Indications of saturation effects were nly obtained in longitudinal fields. The results have en discussed on the basis of existing theory. A.

536.212

99. A method of measurement of the thermal nductivity of fibrous substances. P. KUNZE. *Z. gew. Phys.*, **5**, *No.* 3, 94 (1953) *In German.*

Two similar plates of the material, of thickness h, e clamped together under moderate pressure between o Cu plates at temperature T_2, approx. room temrature. An electrically heated Cu wire, radius r, sistance R per unit length and at temperature $> T_2$ is between the clamped plates. T_1 is measured ermoelectrically. The thermal conductivity, k, is by analogy between the electrostatic field, and thermal, distributions, given by $k = \{RI^2/2\pi(T_1 - T_2)\}ln(4h/\pi r)$, where I is the current in the wire. A test showed that the method yields approximate values but is simpler than the usual plate methods. S. WEINTROUB

536.212.2 : 536.48

6700. The thermal conductivity of gold at low temperatures. G. K. WHITE. *Proc. Phys. Soc.* [*London*] *A*, **66**, 559–64 (*June*, 1953).

Measurements of thermal conductivity at temperatures between 2 and 150°K for several specimens of gold of differing physical and chemical purity are reported. A brief description is given of the cryostat and the experimental technique. Below 35°K the total thermal resistance is given approximately by $R = A/T + BT^2$; apparent small departures from this equation are discussed. The experimental values of B lead to a value of $C \simeq 15$ in the equation for the ideal resistance $R_i = R_\infty CN^{2/3}(T/\Theta)^2$. At temperatures above $\Theta/2$ the conductivity is sensibly constant and no minimum is observed. A.

536.212.3

6701. A method for shortening the experimental time of a thermal conductivity determination by the Poensgen plate method. W. OSWALD. *Z. angew. Phys.*, **5**, *No.* 4, 130–3 (1953) *In German.*

The time of determination by the parallel plate method is shortened from 1–4 days to a few hours when low conductivity materials are being tested. A higher electrical input than usual is fed intermittently so that equilibrium is reached more rapidly but the actual measurement is made under slightly varying conditions. A system of thermocouples, galvanometers and photocell relays determines whether or not the input is applied to the hot plate. The thermocouples measure the temperature differences between the two plates and keep this at a constant value, another couple maintains the guard ring at the desired temperature. The actual heat input is measured by means of a sensitive watt-hour meter and the results are considered accurate to ±2%. E. H. DOCK

536.23 : 536.25

6702. Ratio of convection to conduction loss from a hot wire stretched along the axis of a vertical cylindrical tube. J. A. V. FAIRBROTHER. *Brit. J. appl. Phys.*, **4**, 204–6 (*July*, 1953).

The ratio of the axial heat loss by convection to the radial heat loss by conduction for a wire mounted on the axis of a vertical tube is calculated for two cases: (*a*) when the tube is open at both ends to allow unrestricted circulation, and (*b*) when the tube is closed at both ends. The calculations are based on the assumption that the axial flow is not so large as to cause the form of the radial temperature drop to depart appreciably from the logarithmic and that the system is sufficiently long for end effects to be negligible. The elementary calculations made possible by these simplifying assumptions show that for a radius of wire of 0·05 cm and of the cylinder 0·25 cm, the axial heat loss for the closed case is about 7·5 times smaller than for the open case. For a 10 cm long tube with temperature drop between the wire and the surrounding tube of 1°C, the calculation for water shows that the axial heat loss is 2·5% of the radial heat loss

for the open case and 0·3% for the closed case. For air under the same conditions the axial heat loss is 0·2% of the radial for the open case and 0·003% for the closed case. A.

536.24 : 532.51

6703. On the theory of heat transfer in parallel oil layers. B. Dizioğlu. *Rev. Fac. Sci. Univ. Istanbul A*, **17**, 159–77 (*April*, 1952) *In German.*

An approximation method for the solution of the boundary-value problems in heat transfer across layers of oil enclosed between parallel plates, one of which moves, is developed. Laminar flow is of course assumed, together with strict limits of temperature distribution and constant viscosity. In a later paper the variation of viscosity will be included. The possibilities of the method are thoroughly discussed. T. C. TOYE

536.24 : 541.123.5

On the mathematics of exchange processes in fixed columns. *See Abstr.* 7228–9

536.25

6704. Convection from an isolated heated horizontal cylinder rotating about its axis. J. T. Anderson and O. A. Saunders. *Proc. Roy. Soc. A*, **217**, 555–62 (*May* 21, 1953).

The heat transfer by convection from an isolated heated horizontal cylinder rotating about its axis in air was measured for varying rotational speeds, cylinder temperatures and diameters; some measurements were also made in air at 4 atm pressure. The results show that the heat transfer is nearly constant at the free convection value for rotational speeds from zero to a critical value, and then increases in proportion to the $\frac{2}{3}$ power of the rotational speed. The explanation of the constant heat transfer below the critical speed is shown to be that the heat transfer on the ascending side of the cylinder is higher, and that on the descending side lower, than the free convection at zero speed. The critical speed occurs when the circumferential speed of the rotating surface becomes approximately equal to the upward free convection velocity at the side of the heated stationary cylinder. Theory predicts this to occur at approximately $R\sqrt{(P/G)} = 0{\cdot}9$, which agrees well with the experimental values. Photographs of the flow also confirm these conclusions. Above the critical speed the irregular turbulent motion near the cylinder is shown to be similar to that which occurs in free convection above a heated horizontal surface facing upwards. Starting with known values for the free convection in the latter case, the heat transfer from the rotating cylinder above the critical speed was deduced and agrees well with the experimental results. A.

536.253

6705. Free convection over parallel sources of heat. H. Rouse, W. D. Baines and H. W. Humphreys. *Proc. Phys. Soc.* [*London*] *B*, **66**, 393–9 (*May*, 1953).

One phase of a fundamental investigation of convection over point and line sources of heat, conducted through the past decade at the Iowa Institute of Hydraulic Research, simulated a method of fog dispersal used for the landing of aircraft in England during the war. This involved the release of heat from parallel lines of burners, the convection from which produced characteristic patterns of mean fl and of heat intensity above the burners. Experime described in this paper consisted of the measurem the velocity distribution and the temperature distri tion at various model scales and rates of heat gene tion. The results have been reduced to dimensionl diagrams of the two distribution functions wh satisfy the elementary continuity and impul momentum requirements. From these diagra generalized families of stream lines and isotherms the mean motion above the sources have been plott The general functions reveal the basic pattern convection and permit the approximate evaluation velocity and temperature rise for any desired combi tion of the independent variables.

536.2

6706. Convection currents in porous media. Variational form of the theory. F. T. Rogers, *J. appl. Phys.*, **24**, 877–80 (*July*, 1953).

For Pt IV, see Abstr. 1707 (1952). A theory the mean thermal gradient at the onset of convect flow of a fluid in a porous medium and heated fr below, is given in variational form. Therm equilibrium is not assumed, nor is viscosity assum to be constant. An approximate solution is giv for the theory, and is shown to agree quite well w published data. No attempt is made to mainta complete mathematical rigour in the derivations.

536.

6707. Use of a solar energy accumulating furnace dilatometric studies. R. Chalmin. *C.R. Acad. S* [*Paris*] **236**, 1638–40 (*April* 27, 1953) *In French.*

The collected solar energy is directed to an inn space containing the specimen. The temperature the mid-point of the length is measured optically thermo-electrically according to the range. Chang in length are measured by an optical comparator sit on the ends of the specimen through holes in t furnace wall. Temperatures up to 2000°c have bee maintained with an accuracy of ±10°c. Changes length have been measured to 1/200 mm in the low range and to 1/100 mm at the highest temperature an error of less than 0·05%. E. H. DOO

536.4

6708. A method for the measurement of the therm expansion of solids between 0 and −180°c. Michels, T. Wassenaar and T. N. Zwieterin *Physica*, **19**, 371–3 (*April*, 1953).

Rapid determination of the coefficient of line expansion of a solid by comparison with a referen material i.c. Jena 16^{III} glass.

536.413 : 536.631 : 537.311.33 : 548.736.3 : 538.22

Study of the development of some properties vanadium oxide in the neighbourhood of its transform tion temperatures. *See Abstr.* 6951

536.422

6709. Rates of evaporation. VI. The vapour pre sure and rate of evaporation of potassium chlorid R. S. Bradley and P. Volans. *Proc. Roy. Soc.* 508–23 (*May* 21, 1953).

For Pt V, see Abstr. 3486 (1951). The vapou pressure of potassium chloride has been determine by an effusion method at 438 to 597°c and is give

$\log_{10} p$ mm of Hg $= -11\,310/T + 10{\cdot}451$; the nt heat of vaporization over this range is 51 720 ± cal mole^{-1}, giving a value of 54 430 ± 500 cal le^{-1} at 0°K. The rate of evaporation of single stals has been determined at 399 to 515°c. The poration coefficient for (100), (111) faces is 2 ± 0·015 (independent of temperature). A stal with (110) and (100) faces gave an evaporation fficient of 0·63 (independent of temperature), gesting that the evaporation coefficient for the 0) face is 0·56. A.

536.422.1

10. Rates of evaporation. VII. The theory of the e of evaporation and vapour pressure of potassium oride. R. S. Bradley. *Proc. Roy. Soc. A*, **217**, 1–9 (*May* 21, 1953).

The vapour pressure of potassium chloride as culated from spectroscopic and specific heat data ees well with experiment if the latent heat of porization at 0°K is taken to be 55 250 cal mole^{-1}. e rate of evaporation is of the same order as that duced by the theory of Polanyi and Wigner. aporation is analysed in terms of a two-stage chanism with a mobile surface layer as inter- diate between the solid and vapour phases. A.

536.423

11. On the condensation of metallic vapours on t surfaces. W. Opitz. *Z. Phys.*, **135**, *No.* 1, 1–12 953) *In German.*

A new method is described for the measurement of e vapour jet pressure of a condensing metal as a nction of the temperature of a receiving surface *vacuo*. The surface (a tungsten strip) combines e functions of radiometer and part of a thermometer. he tungsten strip is calibrated with weights using an ectromagnetic balance. It is heated electrically, its mperature being measured with an optical pyro- eter. The point of condensation is determined in e of three ways: (*a*) when the strip current is reduced, e evaporating temperature being kept constant, the ip temperature rises sharply when the heat of ndensation is released; (*b*) the emissivity of the strip anges abruptly when condensation takes place; the pressure changes when the vapour jet is no nger reflected. Data are presented for 13 metals. ie log plots of pressure against radiometer and aporation temperature respectively are linear, but ow kinks in some cases. They agree moderately th the saturation vapour pressure curves culled m the literature. The errors in the (absolute) lues of the pressure measurements and theoretical plications are discussed in some detail. R. A. Weale

536.423.15

12. Vapour pressure of liquid nitrogen. A. ichels, T. Wassenaar, W. de Graaff and C. Prins. *ysica*, **19**, 26–8 (*Jan.–Feb.*, 1953).

The vapour pressure of liquid nitrogen has been easured between −176°c and −148°c. The results e represented as a function of temperature by a rmula containing four constants. A.

536.424

13. On the transition points of anhydrous sodium rbonate. J. Jaffray and P. Martin. *C.R. Acad. i.* [*Paris*] **236**, 1755–6 (*May* 4, 1953) *In French.*

Two clear transition points at 360°c and 480°c have been found. The first of these is accompanied by no marked structural change, but between 420°c and 500°c a profound change is shown in the X-ray spectra. F. E. Hoare

536.44

6714. The critical properties of elements and compounds. K. A. Kobe and R. E. Lynn, Jr. *Chem. Rev.*, **52**, 117–236 (*Feb.*, 1953).

A review of the literature on critical constants covering the following topics: (*a*) the main experimental methods, (*b*) empirical relations that have been proposed to estimate the constants, (*c*) the actual values of p_c, T_c and v_c for 17 elements, 164 organic compounds and 40 inorganic compounds. The latter section contains extensive comparative notes on techniques, purity and accuracy. 352 references.

R. O. Davies

536.44

6715. The carbon-dioxide–nitrous-oxide system in the critical region. D. Cook. *Proc. Roy. Soc. A*, **219**, 245–56 (*Aug.* 25, 1953).

The phase boundaries, orthobaric densities and critical constants of five mixtures of carbon dioxide and nitrous oxide have been measured between 20°c and the critical point. The same physical properties for the two pure gases have also been measured. The apparatus consisted of a calibrated thick-walled hard-glass pressure tube, fitted with an electromagnetic stirrer, for visual observation of the dew-points, boiling-points and critical points, plus auxiliary equipment for precise temperature and pressure measurements. The results, which show the system to be almost ideal with small positive deviations from Raoult's law, are interpreted satisfactorily by the theory of conformal solutions. The results also agree with other experimental data on the transport properties of carbon-dioxide–nitrous-oxide mixtures, and with measurements of the isothermal expansion coefficients of such mixtures, but not with a previous investigation of the phase behaviour of the system. A.

536.46

6716. Burning velocity measurements. D. M. Simon and E. L. Wong. Letter in *J. chem. Phys.*, **21**, 936 (*May*, 1953).

High-speed schlieren cine-photographs (approx. 7000 frames/sec) of a flame propagating in a mixture of 28·3% CH_4, 18% N_2, 53·7% O_2 contained in an aqueous soap bubble (initial dia. 4 in.) show that the flame front becomes disturbed over the last two-thirds of its travel. The flame speed is accordingly increased (by 50% for a 4 in. dia. bubble, and by 30% for a 2 in. dia. bubble). It is suggested that this phenomenon is responsible for the higher values of the burning velocity of methane-oxygen flames obtained by the soap bubble than by the burner method. A. Schofield

536.46

6717. Hydrogen-fluorine flame temperatures. D. Altman and M. Farber. Letter in *J. chem. Phys.*, **21**, 1118 (*June*, 1953).

Hydrogen-fluorine flame temperatures calculated from the available enthalpy and entropy tables show that the value measured by Wilson *et al.* [*J. Amer. Chem. Soc.*, **73**, 5514 (1951)] of 4300 ± 150°K is

incompatible with the recently measured low value of $D_0(F_2) = \sim 37$ kcal/mole, but agrees with the previously accepted value of ~63 kcal/mole. F. LACHMAN

536.46

6718. Effects of self-absorption on rotational "temperatures" of OH in flames. H. P. BROIDA. *J. chem. Phys.*, **21**, 1165–9 (*July*, 1953).

Penner's method of calculating effects of absorption on measured OH($^2\Sigma^+$) rotational distributions has been applied to the R_2 branch and the results compared with intensity measurements of acetylene-oxygen flames at atmospheric pressure. It is shown that distributions in the hot gases above the reaction zone are in agreement with calculated distributions and that for isothermal regions the method can give both emissivity and rotational "temperature," even when there is appreciable self-absorption. Measured intensities in the reaction zone indicate that there is a rotational "temperature" several hundred degrees in excess of the adiabatic temperature and that the "temperature" of the emitters is greater than that of the absorbers. A.

536.461

6719. Current theoretical concepts of steady-state flame propagation. M. W. EVANS. *Chem. Rev.*, **51**, 363–429 (*Dec.*, 1952).

A comparative survey, including the comprehensive theories of (*a*) Lewis and von Elbe, (*b*) Zeldovich *et al.*, (*c*) Boys and Corner, (*d*) Hirschfelder and Curtiss, four examples of purely thermal theories, and five diffusion-mechanism theories. A bibliography of 116 references is appended. A. SCHOFIELD

536.461

6720. A slot burner method for studying combustion wave instability. G. H. MARKSTEIN AND L. M. SOMERS. Letter in *J. chem. Phys.*, **21**, 941 (*May*, 1953).

Premixed combustible gases, after passing through a settling chamber, emerge through a slot approx. 16 cm long × 2·5 mm wide (the width is adjustable). The flame is prevented from attaching itself to one side of the burner slot by a stream of N_2 issuing from a parallel auxiliary slot, and the flame is stabilized by withdrawing a portion of the products of combustion through a water-cooled suction slot near the flame base. A stable flame on this burner is almost plane: unstable flames are fluted, the spacing of the flutes providing a convenient measure of the wavelength of the flame-front distortion, while the depth of the flutes indicates the intensity of the disturbance. A. SCHOFIELD

536.48

6721. On the hydrodynamics of non-viscous fluids and the theory of helium II. II. A. THELLUNG. *Physica*, **19**, 217–26 (*March*, 1953).

The theory developed in a previous publication [Abstr. 3255 (1953)], which was confined to the irrotational flow of a non-viscous fluid, is extended so as to include vortex motions. With the aid of a transformation due to Clebsch it is possible also in this general case to bring the hydrodynamical equations into a canonical form. The total Hamiltonian is then found to consist of three parts of which the first, involving only the "phonon field," was dealt with in the earlier work. The second part contains exclusively the "roton field," while the third represents an interaction between the two fields. this way the concepts introduced by Landau connection with his intepretation of the properties helium II can be given a more secure foundat Quantization is carried out along the usual lines field theory. A determination of the eigenvalues the Hamiltonian has not yet been achieved.

536

6722. On the molecular theory of liquid heli II. The coefficient of thermal expansion of liq helium. I. PRIGOGINE AND J. PHILIPPOT. *Physi* **19**, 227–34 (*March*, 1953) *In French.*

The cell model applied to liquid helium by authors [Abstr. 3250 (1953)] is slightly extend The volume per cell and the total number of c are obtained by the condition of minimum free ener In this model the number of cells which accommod two particles is no longer equal to the number of c with zero particles. The results obtained in the f paper are not appreciably changed but the pres model explains the anomalous specific heat a increase of entropy, and also the negative therm dilatation of liquid helium at temperatures below λ-point.

536

6723. On the molecular theory of liquid heliu III. The solutions of He^3 and He^4. I. PRIGOGINE A J. PHILIPPOT. *Physica*, **19**, 235–40 (*March*, 1953) *French.*

The positive deviations from Raoult's law whi have been experimentally observed in He^3–H solutions are discussed on the basis of the cell mod used in the preceding papers [Abstr. 3250 (1953) a preceding abstract]. It is shown that this effect primarily due to the difference of masses of the tw isotopes and so to the difference in the zero poi energy. The statistics plays only a secondary role introducing an excess entropy of mixing. Th difference is shown to give rise to a positive exce energy which is of the right order of magnitud A negative excess volume (contraction on mixing) predicted on the basis of this model.

536.4

6724. The λ-transition in liquid helium. R. P. FEYNMAN. Letter in *Phys. Rev.*, **90**, 1116 (*June* 1 1953).

It is shown that the only permutations contributin appreciably to the partition function are those in whic the atoms are either left in their original positions c moved to a neighbour. A cycle of r adjacent atom each moved to the position of the next contributes factor y^r, where $y \sim \exp(-\frac{1}{2}md^2kT/\hbar^2)$, with $d \sim$ mean atomic spacing and $m \sim$ He mass. Considerin lines joining atomic centres, each permutation cycl corresponds to a polygon on the configuration. Th factor by which the Einstein–Bose p.f. differs fro the Boltzmann is then $q \sim \Sigma_L g(L) y^L$, where $g(L)$ is th total number of ways polygons can be drawn on th configuration such that the total number of sides o all polygons together is L, the polygons not bein allowed to cross. The transition in behaviour of occurs when the contributions from very larg polygons suddenly begin to be important. R. B. DINGL

536.48

25. Thermodynamic properties and melting of id helium. J. S. DUGDALE AND F. E. SIMON. *Proc. y. Soc. A*, **218**, 291–310 (*July* 7, 1953).

The melting properties and thermodynamic functns of solid helium have been determined at temratures from 4 to 26°K and at pressures up to 00 atm. The upper temperature corresponds to out five times the critical temperature of helium; was therefore possible to measure properties of the id state in a range which has not yet been attained any other substance. The melting curve shows no ns of an approach to a solid-fluid critical point; fact, the difference between the phases becomes more onounced at higher melting temperatures. The ernal energy at 0°K was calculated from the experiental data and was found to be in good agreement th the theoretical values based on the Slater–rkwood potential, using $\frac{9}{8}R\theta$ as an estimate of the ro-point energy (θ being the Debye characteristic mperature). A first-order transition in the solid is revealed; its equilibrium line cuts the melting rve at 14·9°K and moves to higher temperatures at gher densities. The heat of transition is very small, out 0·08 cal/mole. The transition is assumed to rrespond to a change of crystal structure from xagonal to cubic close-packed. At the highest essure solid helium is compressed to less than half volume under equilibrium conditions at absolute ro, and the Debye θ is increased five times. It was nce possible to test the Lindemann melting formula r a single substance over a very wide range. The rmula was found to fit the experimental data satisctorily, although the value of the constant in it ffered somewhat from the classical value. A.

536.48 : 530.145 : 532.51

726. Quantum hydrodynamics and the theory of quid helium. J. M. ZIMAN. *Proc. Roy. Soc. A*, **219**, 57–69 (*Aug.* 25, 1953).

The Clebsch formula, $\mathbf{u} = -\nabla\phi - \chi\nabla\psi$, for the uid velocity allows the classical hydrodynamical quations, including vorticity, to be derived from a ariational principle, and put into canonical form. he standard quantization procedure of the theory of elds then gives a set of field operators satisfying the ommutation relations obtained (starting from ifferent premises) by Landau (1941). The Hamilonian contains terms corresponding to the excitation f the "roton" states of Landau's theory, with an nergy spectrum (allowing for the atomicity of real quids by a "cut off" in the Fourier analysis of the eld variables) of the form $E = \Delta + p^2/2\mu$. The bserved variations of specific heat and second-ound velocity in liquid helium II may be interpreted o give values of Δ in good agreement with the theory, vith an apparent variation of μ with p, perhaps ttributable to roton-roton and phonon-roton nteractions. A.

536.48

727. Superflow of helium II through compressed owder. B. S. CHANDRASEKHAR AND K. MENDELSOHN. *Proc. Roy. Soc. A*, **217**, 18–28 (*June* 9, 953).

The flow of liquid helium II through a tube packed with rouge powder has been investigated under gradients of temperature and pressure. The flow rate, the heat current and the pressures at the ends of the tube as well as at an intermediate point have been determined at various temperatures. In flow under a thermal gradient a similar character to that earlier established for flow through narrow slits has been observed. Up to a certain critical velocity which depends on temperature, the flow is free of friction, while at higher velocities, dissipation sets in. The flow under gravity differed completely in its behaviour from the observations with the slit, since dissipation occurred at all velocities. This inconsistency in the flow phenomena has been discussed but no satisfactory explanation can be offered. A.

536.48

6728. Fountain effect in Helium II below 1°K. G. J. C. BOTS AND C. J. GORTER. Letter in *Phys. Rev.*, **90**, 1117 (*June* 15, 1953).

Using a tube filled with very fine Fe_2O_3 powder, the integrated fountain effect between 0·5°K and 0·8°K was found to be about 5 cm, while below 0·5°K it was not more than a few mm. London's formula predicts 7·3 cm and 1·3 cm respectively. R. B. DINGLE

536.48

6729. Second sound velocity in He^3–He^4 mixtures below 1°K. J. C. KING AND H. A. FAIRBANK. Letter in *Phys. Rev.*, **90**, 989–90 (*June* 1, 1953).

Velocity measurements using a single pulse technique show that (*a*) the second-sound velocity for pure He^4 reaches a value of 215 m/sec below 0·25°K, the pulse shape being greatly distorted, and (*b*) for He^3–He^4 mixtures with concentrations ranging from 0·017 to 4·3% He^3, the velocity possess a maximum (~1°K for 4·3%), in general agreement with Pomeranchuk's prediction [Abstr. 5399 (1953)]. There is little pulse distortion, probably because the phonon mean free path is reduced by interactions with the He^3 atoms. R. B. DINGLE

536.48

6730. Heat pulses in helium II between 0·1°K and 1·0°K. H. C. KRAMERS, F. A. W. VAN DEN BURG AND C. J. GORTER. Letter in *Phys. Rev.*, **90**, 1117 (*June* 15, 1953).

Below about 0·2°K in a cavity of 6 cm length, and below 0·35°K in one of 3 cm, the sharp start of a heat pulse was found to propagate with a velocity of 230 m/sec. In both cavities, the usual second sound was found above about 0·8°K. Between these temperatures, the apparent velocity of the pulse in the 6 cm cavity was smaller than in the 3 cm.

R. B. DINGLE

536.5 : 538.566 : 621.396.9 : 621.396.62 : 621.317.79

6731. On the sensitivity of a radio thermometer. V. S. TROITSKIĬ. *Zh. tekh. Fiz.*, **22**, *No.* 3, 455–60 (1952) *In Russian.*

A theoretical discussion of the possibility of measuring temperatures by the use of signal/noise ratios in radio receivers. Discusses both the case of noise in a circuit component and also aerial noise as thermometric elements. It is concluded that theoretically this method is sufficiently sensitive to make such a thermometer a possibility. J. M. HOUGH

536.52

6732. A fast, electro-optical, hot-gas pyrometer. G. H. Millar, J. G. Winans, O. A. Uyehara and P. S. Myers. *J. Opt. Soc. Amer.*, **43**, 609–17 (*July*, 1953).

The theory, development and design features of a fast, electro-optical pyrometer are given. This pyrometer, whose response can be made very rapid, will continuously indicate the temperature of hot gases that are either naturally luminous or are made luminous at particular wavelengths. There is discussion of the optical design features to be considered in this and other similar instruments and of the equality of the defined terms, emissivity, and absorptivity. A.

536.521 : 535.233

Portable photographic pyrometer. *See Abstr.* 6582

536.532

6733. The construction of radiation thermocouples using semi-conducting thermoelectric materials. D. A. H. Brown, R. P. Chasmar and P. B. Fellgett. *J. sci. Instrum.*, **30**, 195–9 (*June*, 1953).

536.622

6734. Precision measurements of the enthalpy of KBr and KI at high temperatures. C. B. Cooper. *J. chem. Phys.*, **21**, 777–9 (*May*, 1953).

By use of an ice calorimeter precision measurements of the enthalpies of pure samples of KBr and KI between 300°C and their melting points were made. Values for the specific heats at constant pressure of these substances through the same temperature range were calculated and tabulated. A.

536.629 : 621.369

6735. A compensation process for the measurement of industrial heat flows applied to the investigation of the efficiency of electric cookers. H. Bock and H. Golde. *Dtsch. Elektrotech.*, **7**, 187–90 (*April*, 1935) *In German.*

The constructional details of a liquid-flow calorimeter which is used to measure the stationary heat flow from cooker hot-plates are given. The arrangement by which the flow in the calorimeter is adjusted to equal that of the cooker is described and the theory is explained. A set of test measurements is given and discussed. S. WEINTROUB

536.631 : 536.48

6736. The specific heat of crystalline selenium at low temperatures. W. Desorbo. *J. chem. Phys.*, **21**, 1144–8 (*July*, 1953).

Studies on the low temperature specific heat of crystalline selenium have been extended down to 15°K. The data are compared with a calculation based on a one-dimensional-continuum model with which good agreement is shown to exist down to about 37°K. Below this temperature, deviations are described in terms of an anisotropic continuum which considers the "interaction" between atom chains. The values of the thermodynamic functions, entropy, enthalpy, and free energy have been evaluated and tabulated at regular integral values of temperature up to 300°K. The entropy of crystalline selenium at 298·16°K is 10·15 ± 0·05 cal/g-atom/deg, of wh 0·22 was obtained by extrapolating below 15 For this extrapolation, the anisotropic-continuu model was used.

536.658 : 53

6737. Some thermodynamic properties of metha adsorbed on rutile between 80 and 140°K. E. Pace, E. L. Heric and K. S. Dennis. *J. che Phys.*, **21**, 1225–8 (*July*, 1953).

Heat capacities of methane adsorbed on rut (titanium dioxide) have been determined from 80 140°K for concentrations corresponding to t fractions 0·28, 0·56, 0·84 and 1·11 of the monolay capacity. Integral heats of adsorption, determin at 110, 120, 130 and 140°K, show correlation with th heat capacities within the experimental error. Th thermodynamic functions, ΔH, ΔS and ΔF of th differential adsorption process, have been calculate from the data. The heat capacities indicate a adsorbate having properties differing from bul methane and possessing some degree of mobility ov the surface. No first-order phase changes were i evidence for the concentrations studied. At lo surface coverages, the shape of the differential hea of adsorption curve points to the presence of a heterc geneous adsorbent surface, while at coverage approaching the monolayer, dispersion forces ar probably in effect. All the differential thermodynami quantities approach the values for liquid methane a coverages greater than the monolayer in the tem perature range from 110 to 140°K. A

THERMODYNAMICS 536.7/.8

536.

6738. On the extension of thermodynamics t irreversible phenomena linked to internal degrees o freedom. I. Prigogine and P. Mazur. *Physica* **19**, 241–54 (*March*, 1953) *In French.*

By introducing an internal configuration space and assuming continuous motion therein, the second principle of thermodynamics can be stated in the following way: the entropy creation per unit volume of the internal configuration space is essentially positive definite. Explicit evaluation of this entropy creation then at once leads to differential equations of diffusion type for the motion in configuration space. For ideally dilute systems, these equations reduce to generalized Fokker–Planck equations. As a conse quence of Onsager reciprocal relations it is shown that the phenomenological friction tensor in con figuration space must be symmetric. The formalism thus obtained can be applied to a great variety of irreversible phenomena related to internal degrees of freedom. Finally, some very simple applications are discussed as an illustration. A.

536.7

6739. Nonequilibrium thermodynamics. N. A. Hall. *J. appl. Phys.*, **24**, 819–25 (*July*, 1953).

The foundations and implications of the concepts essential to the thermodynamic analysis of non-

uilibrium systems are investigated. Following a view of the background developments in irreversible ermodynamics the concept of thermostatic isolation introduced. This provides a conceptual device ereby a thermostatic state may be established for y nonequilibrium system and a means of justifying tended use of basic relations of classical thermo- namics or thermostatics. The conventional deve- pment of the form of entropy production is outlined. his in general is the sum of extrinsic entropy produc- on and intrinsic entropy production. The former curs as the sum of products of generalized diffusion fects and property gradients and is the result of teractions with discrete adjacent systems. The tter occurs as the sum of products of generalized finities and generalized reaction rates and is the sult of interaction between geometrically coincident verlapping systems. Between the diffusion effect nd gradients of extrinsic entropy production generally ccur linear relations with phenomenological co- fficients subject to the Onsager reciprocal relations. he intrinsic entropy production occurs as a relaxa- on phenomenon developed from the first-order elaxation between the affinity and the displacement f the reaction from equilibrium. The relation of he ultimate limits of applicability of thermodynamics o the uncertainty in establishing thermostatic state nder conditions of microscopic fluctuations is liscussed. A.

536.7 : 530.162

The statistical mechanics of irreversible processes. *See Abstr.* 6492–3

536.7 : 530.162

Generalized statistical mechanics and the Onsager elations. *See Abstr.* 6494

536.7 : 532.72

5740. On variational principles for irreversible processes. P. Rosen. *J. chem. Phys.*, **21**, 1220–1 (*July*, 1953).

A variational principle is formulated for diffusional processes such as heat and matter diffusion which is a modification of Onsager's principle of minimum dissipation. Also a variational principle is given for the flow of viscous incompressible fluids which has some analogy to Onsager's principle. A.

536.71 : 532.74

6741. Radial distribution functions and the equation of state of monatomic fluids. R. W. Zwanzig, J. G. Kirkwood, K. F. Stripp and I. Oppenheim. *J. chem. Phys.*, **21**, 1268–71 (*July*, 1953).

An approximation is obtained for the radial distribution function in a fluid whose molecules interact with the Lennard–Jones potential. Calculations of the equation of state, the internal energy, and the compressibility are presented and compared with experiment. At temperatures and volumes higher than the critical, agreement with experiment is satisfactory. A systematic method is developed of modifying the theoretical radial distribution function so that calculated thermodynamic quantities agree with their experimental values. In the liquid phase, slight modifications are needed to obtain agreement with experiment. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

6742. A method of measuring the charge of fast-moving electrons. R. Fleischmann and R. Kollath. *Z. Phys.*, **134**, *No.* 5, 526–9 (1953) *In German.*

Gives the simple theory of an experiment in which the displacement current caused by electrons passing through cylindrical electrodes may be related to their charge. J. D. CRAGGS

537.12

6743. The measurement of the charge of moving electrons. R. Kollath and D. Menzel. *Z. Phys.*, **134**, *No.* 5, 530–9 (1953) *In German.*

Experimental details for the method of the preceding abstract. Dimensions of the tube, circuit details, and typical oscillograms of current pulses are given, the energy range being 2·5–30 keV. J. D. CRAGGS

ELECTROSTATICS . DIELECTRICS 537.2

537.21

6744. Some electrostatic and steady-current problems involving anisotropic bodies. R. Cade. *Proc. Phys. Soc.* [*London*] *B*, **66**, 557–69 (*July*, 1953).

Solutions are given of six new electrostatic and steady-current problems involving anisotropic spheres and spheroids influenced by uniform electric fields. In the electrostatic problems derivations are given of the potentials and the mechanical action on the solid bodies; in the corresponding steady-current problems the physical principles are formally similar and the results are usually obtained by analogy. At the beginning careful consideration is given, in the light of modern knowledge, to the validity of the Maxwell stresses, which are subsequently used to obtain the mechanical action results. At the end a brief critical discussion is made of the possibility of utilizing these results experimentally for the determination of crystalline dielectric constants and conductivities. A.

537.212 : 538.12 : 621.3.013

6745. The two-dimensional magnetic or electric field above and below an infinite corrugated sheet. N. H. Langton. *Brit. J. appl. Phys.*, **4**, 134–7 (*May*, 1953).

The sheet may be regarded as a magnetized ferromagnetic body, or a charged electrical conductor. The corrugations are parallel, semi-circular cylinders. The method involves the use of conformal transformations and elliptic integrals. Tables and graphs of the field strength at important points are given. A.

537.213 : 621.3.015.1

6746. Charged disk in cylindrical box. W. R. Smythe. *J. appl. Phys.*, **24**, 773–5 (*June*, 1953).

The mixed boundary value problem of the potential inside a cylindrical conducting box of radius a and

height $2c$ in which is mounted coaxially and concentrically a thin flat charged conducting disk of radius b is solved approximately. A formula for the coefficients in the Bessel function potential series is derived which is valid for $c < \frac{1}{4}a$ and $b < \frac{3}{4}a$. The boundary conditions are met rigorously except that the disk is not quite flat. Figures show its deviation for twelve parameter values. A formula for narrow gaps is derived. Upper and lower limits for the capacitance for twelve parameter values are tabulated. A.

537.221

6747. On the triboelectric properties of polyvinyl chloride. E. Darmois and A. Marais. *C.R. Acad. Sci.* [*Paris*] **236**, 1456–8 (*April* 13, 1953) *In French.*

Results of experiments on fabrics containing P.V.C. in the form of continuous filament and staple fibre and P.V.C. mixed with other textile fibres are presented. Surface densities of charge were measured with a proof-plane and Faraday cylinder. Pure P.V.C. was always charged negatively whatever the rubbing material and the magnitude of the charge was limited by the electric breakdown strength of the air. Fabrics of P.V.C. mixed with other fibres developed smaller charges. A. E. KAY

537.221

6748. Surfaces showing no electrification after light contact with metals. W. R. Harper. *Proc. Roy. Soc. A*, **217**, 111–21 (*June* 9, 1953).

An experimental investigation of the static electrification of insulating surfaces after light contact with metals shows that hydrophilic surfaces such as glass acquire a considerable charge, whereas hydrophobic surfaces such as amber show negligible charging by comparison. The theoretical significance of this is discussed. A.

537.221

6749. Frictional electrification of polar polymers. J. A. Medley. Letter in *Nature* [*London*] **171**, 1077 (*June* 13, 1953).

It is indicated that polar polymers such as textiles and ion-exchange resins are suitable materials for investigating electrolytic charge separation. The presence of the acid or basic groups promotes water sorption and consequent ionic dissociation even at low humidities. Tests with resins in powder form at 30% r.h. showed the basic resin to be positively charged and the acid one negatively charged with respect to filter paper. Treatment with dilute caustic soda reverses the electrification. The direction of charge transfer is given by the sign of the boundary potential as deduced from the Donnan theory.

A. E. KAY

537.226.1

6750. The effective dielectric constant of solid mixtures. J. P. Poley. Letter in *Physica*, **19**, 298–300 (*March*, 1953).

It is shown that the macroscopic permittivity ε_m of a mixture of components of permittivity ε_1 and ε_2, cannot be expressed by a single relation, because (1) when the volume filling factor of one component in the other is increasing, the surroundings of any particle cannot be treated as a continuum, (2) the components, being of different shape, are not physically interchangeable. Values of ε_1 or ε_m cannot therefore be predicted from mixture data, using relations such as derived by Stevels [*Rec. Trav. Chim. Pays-Bas*, **66**, 71 (1942)]. J. H. MASON

537.22

6751. Green's "correction" of Yvon's dielectric constant formula. W. F. Brown, Jr. Letter in *J. chem. Phys.*, **21**, 1121 (*June*, 1953).

The dielectric constant formulae for non-polar fluids as derived by Green (1952), by Yvon (1937) and by Brown (1950), are in essential agreement despite superficial differences. D. H. WHIFFEN

537.226.1 : 621.3.011.5

6752. The electric permittivity of a dilute suspension of membrane-covered ellipsoids. H. Fricke. *J. appl. Phys.*, **24**, 644–6 (*May*, 1953).

Deals with the low frequency permittivity (ε) of a dilute suspension (conductivity σ, volume concentration ρ), in a conducting medium (conductivity σ_s, permittivity ε_s), of ellipsoidal particles (major axis $2a$) each composed of a conducting core covered with a nonconducting surface membrane (thickness t, permittivity ε_m). The quantity $[\varepsilon - (\sigma/\sigma_s)\varepsilon_s]/(\rho a\varepsilon_m/t)$ is expressed in terms of Weierstrass' elliptic functions of the axial ratios, for parallel and random arrangement of the ellipsoidal axis. A table of its numerical values is given. A

537.226.2

6753. Dielectric properties of some solid proteins at wave lengths 1·7 meters and 3·2 centimeters. E. R. Laird. *Canad. J. Phys.*, **30**, 663–9 (*Nov.*, 1952).

Measurements have been made of the dielectric constant and the attenuation coefficient of casein, egg albumin, lactalbumin, and zein, in powder form at λ 1·7 meters and λ 3·2 cm, and of horn keratin, at stages in drying, at λ 3·2 cm. The Böttcher formula was used to reduce the observed value of the dielectric constant of a powder to that of the solid. It was tested on cane sugar in granulated and powder forms with satisfactory results. The attenuation coefficients of the powders were found to be roughly inversely proportional to the wavelengths. The values at λ 3·2 cm were in the range 0·03 to 0·04 cm^{-1} and did not suggest resonance absorption. The dielectric constants found for the albumins at both wavelengths were close to 3·6. ε for zein increased from 3·7 at λ 3·2 cm to 4·0 at λ 1·7 metres, for casein from 4·0 to a possible 4·2. ε for keratin increased from 3·6 when dry to 4·4 with 6·5% moisture, and α increased from 0·05 to 0·14 cm^{-1}. A.

537.226.2

6754. Note on the dielectric relaxation in glycerine. J. P. Poley. Letter in *Physica*, **19**, 301–2 (*March*, 1953).

It is shown that the variation of ε'' with log f consists of at least two separate absorption curves, each of which can be analysed using the Cole and Cole plot [*J. Chem. Phys.*, **9**, 341 (1941)]. A continuous distribution function of relaxation times is considered probable; see also Davidson and Cole [Abstr. 8852 (1952)]. J. H. MASON

537.226.2

6755. Study at 9500 Mc/s of the phase transitions some alkaline phosphates and arsenates. J. Le Bot, Le Montagner and Y. Allain. *C.R. Acad. Sci. [Paris]*, **236**, 1409–12 (*April* 8, 1953) *In French.*

By measurements of ε' and ε'' transitions points—probably ferroelectric—are found near 250°K for KH_2PO_4, 165°K for CsH_2PO_4, 100°K for KH_2AsO_4, 80°K for $(NH_4)H_2AsO_4$, 110°K for RbH_2AsO_4 and 145°K for CsH_2PO_4. No transition was found with the hydrated Li and Na salts, nor with anhydrous NaH_2PO_4. D. H. WHIFFEN

537.226.2 : 535.376

Dielectric changes of electroluminescent phosphor during illumination. *See Abstr.* 6666

537.226.2 : 536.424

6756. X-ray analysis of the ferroelectric transition of KH_2PO_4. B. C. Frazer and R. Pepinsky. *Acta cryst*, **6**, 273–85 (*March* 10, 1953).

537.226.2 : 548.736.3

6757. Origin of ferroelectricity in barium titanate and other perovskite-type crystals. H. D. Megaw. *Acta cryst.*, **6**, 739–49 (*Nov.* 10, 1952).

The origin of ferroelectricity is attributed to a small change of bond character occurring in a structure whose geometry is compatible with either ionic or homopolar binding. The dipole moments are associated with the electron orbitals of any or all of the atoms concerned, and are not to be identified with the product of effective charge and displacement, which has no physical meaning. The following structures are considered: the three ferroelectric forms of $BaTiO_3$, $PbZrO_3$, $NaNbO_3$, $KNbO_3$, $NaTaO_3$, $KTaO_3$, $RbTaO_3$, WO_3. The type of structure found is discussed in relation to ionic size and available bonding orbitals, and the temperature dependence of the latter. Perovskite-type structures are classified as single and multiple or puckered, and the use of the term "antiferroelectric" for special cases of the latter class is deprecated. The criterion of ferroelectricity is not the existence of spontaneous polarization but its reversibility in an applied field. A.

537.226.2 : 621.3.011.5 ; 621.315.612.4

6758. Electric properties of ferroelectric ceramics near the Curie point. N. P. Bogoroditskiĭ and G. N. Verbitskaya. *Zh. tekh. Fiz.*, **22**, *No.* 12, 1920–9 (1952) *In Russian.*

Near the Curie point the permittivity decreases continuously with time in ferroelectric ceramics. Such ageing does not change the Curie point. The permittivity can be returned to its initial value by the action of an electric field and also by heating at temperatures above the Curie point. This value is regained for only a short time. At temperatures lower by 15°–20°c than the Curie point the permittivity decreases with time. This does not occur at temperatures above or considerably below the Curie point. The maximum reversible permittivity of ferroelectric ceramics, which are subject to ageing, occurs at higher values of potential of the displacing electric field than in a material not liable to ageing. The variation in permittivity of ferroelectric ceramics with time is due to mutual orientation of domains at the various temperatures. J. LUKASZEWICZ

537.226.2 : 621.317.333.6 : 621.3.015.5 : 621.315.613.9

6759. An experimental investigation of factors influencing the electric strength of potassium chloride crystals. J. H. Calderwood, R. Cooper and A. A. Wallace. *Proc. Instn Elect. Engrs IIA*, **100**, *No.* 3, 105–10. *Disc.* 175–89 (1953).

For abstract see Abstr. 1620 (1953).

537.226.3

6760. Lattice defects in solids and Hertzian spectra: necessity of distinguishing ionic Debye absorption and electronic Debye absorption. M. Freymann and R. Freymann. *C.R. Acad. Sci. [Paris]* **236**, 1256–9 (*March* 23, 1953) *In French.*

See also Abstr. 749 (1953).

537.226.8

6761. Further experiments on the thermodielectric effect [Costa Ribeiro effect]. A. Dias Tavares. *An. Acad. Brasil. Ciénc.*, **25**, *No.* 1, 53–9 (1953).

Solidification or melting at the interface between solid and liquid phases of a dielectric is accompanied by the transfer of charge between the phases [Abstr. 1821 (1951)]. When liquid napthalene solidifies, electron transfer occurs from the solid to the liquid. The resultant positive charge on the solid is distributed throughout its bulk, and not just at the surface. J. H. MASON

537.226.8

6762. On a possible explanation of the Costa Ribeiro effect. A. Dias Tavares. *An. Acad. Brasil. Ciénc.*, **25**, *No.* 1, 91–7 (1953).

It is suggested that there may be different permitted electron energy levels in the liquid and solid phases of materials. When a change of phase occurs, electrons of given energy may remain in the phase for which this energy level is permitted, so that there is a net transfer of charge. J. H. MASON

537.228.1 : 536.71

6763. The linear piezoelectric equations of state. R. Bechmann. *Brit. J. appl. Phys.*, **4**, 210–12 (*July*, 1953).

The different forms of the linear piezoelectric equations of state obtained from the various combinations of the two elastic (stress, strain) with the three electric quantities (field, displacement and polarization) are given in a table. In order to show the similarities of the various piezoelectric constants more clearly, the three groups of piezoelectric moduli (piezoelectric stress constants) usually expressed as e, h, a are denoted respectively by e^E, e^D, e^P and the piezoelectric coefficients (piezoelectric strain constants) d, g, b are expressed by d^E, d^D, d^P. The superscripts refer to the electric quantity, E, D or P, held constant for the direct piezoelectric effect or to the applied electric quantity for the converse effect. A.

537.29 : 532.61

Action of an electric field on the spreading of certain liquids over a plane. *See Abstr.* 6520

ELECTRIC CONDUCTION . CURRENTS
537.3

537.311

6764. Deviations from Ohm's law for very thin metallic films. M. PERROT AND J.-P. DAVID. *C.R. Acad. Sci.* [*Paris*] **236,** 1641–3 (*April* 27, 1953) *In French.*

An analytical method for computing the magnitude of the deviation from Ohm's law is given. In general the deviations are greater for thinner and for the more granular films. C. A. HOGARTH

537.311.081.3 : 621.317.331.081

6765. Modified bridge method for absolute determination of ohm. M. ROMANOWSKI. *Canad. J. Phys.*, **30,** 631–6 (*Nov.*, 1952).

The principal characteristics of Campbell's original bridge for the determination of the ohm (in terms of mutual inductance and time) and of Picard's modification to the bridge are examined. Two other networks for the same measurement are found possible by rearranging components. One arrangement in particular offers advantages over previous methods and was built in an experimental form. In it all important circuit elements are constructed of manganin, rendering the bridge less subject to temperature effects, and no determination of self-inductance is necessary. The new bridge does require a mutual inductance equal to twice the value of the standard. A brief outline of the method for resolving this point is given as part of a more general work under way on the scale of inductance. A.

537.311.1

6766. Note on polar scattering of conduction electrons in regular crystals. H. J. G. MEIJER AND D. POLDER. *Physica*, **19,** 255–64 (*March*, 1953).

The reciprocal relaxation time of conduction electrons due to polar interaction with piezoelectrically active acoustical vibration modes is calculated for two-atomic regular crystals. It is found to be proportional to $T^{1/2}$. It is shown for the case of ZnS (sphalerite) that below 150°K the numerical value of this reciprocal relaxation time is comparable with the reciprocal relaxation time due to polar interaction with optical vibration modes. In crystals with sodium chloride structure the mass difference of the ions can in principle be responsible for polar scattering by acoustical modes. The corresponding reciprocal relaxation time is proportional to $T^{3/2}$. In the special case of LiF it becomes equal to polar scattering by optical modes at about 200°K. A.

537.311.1 : 548.7

6767. The mobility of slow electrons in polar crystals. F. E. LOW AND D. PINES. Letter in *Phys. Rev.*, **91,** 193 (*July* 1, 1953).

A brief preliminary report of new calculations of the mobility of electrons in polar crystals. These are believed to apply also in the case of fairly strong electron-lattice interaction (when ordinary perturbation theory fails). P. T. LANDSBERG

537.311.3

6768. Electrical properties of molybdenite. R. MANSFIELD AND S. A. SALAM. *Proc. Phys. Soc.* [*London*] *B*, **66,** 377–85 (*May*, 1953).

The following electrical properties of natural crystals of MoS_2 were measured: conductivity, H coefficient and thermoelectric power over the te perature range −183°C to 500°C, and the roo temperature change of conductivity in a magne field. It was found that the majority of the specim were *p*-type semiconductors. The variation of mobility of the charge carriers with temperature h been derived and indicates that the scattering of charge carriers is mainly due to thermal vibrations the lattice except at low temperatures when impur scattering becomes important. Reasonable agreeme is obtained between the values of the mobility c culated from the change in conductivity in a magne field, and from Hall coefficient and conductivi measurements. The results of the thermoelectr power measurements, and the variation of the co centration of charge carriers derived from the Ha coefficient are discussed and compared with theory.

537.311.31 : 621.316.8 : 669.21.

6769. On gold–chromium resistance standard A. SCHULZE AND H. EICKE. *Z. angew. Phys.*, *No.* 9, 321–4 (1952) *In German.*

The results of 15 years' experience with thes standards, which are superior to manganin, a reported. The alloy used contains 2·05% by weigh Cr; the specific resistance at 20°C is 0·33 Ω mm²/m Two new types of standards are described in whic the resistance coil is enclosed in an argon-filled glas tube. The resistance values remain constant in tim to within a few parts in 10^6. E. H. SONDHEIME

537.311.3

6770. Electronic conductivity of anthracene singl crystals. H. METTE AND H. PICK. *Z. Phys.*, 134 *No.* 5, 566–75 (1953) *In German.*

The preparation of specimens, and methods o measuring the conductivity σ in the temperatur range 85–190°C, are described. σ is anisotropic there is found to be a fairly low maximum field a each temperature T above which Ohm's law fails and the σ, T relation is characteristic of an intrinsic electronic semi-conductor with a gap width o 1·65 eV. C. A. HOGARTH

537.311.32

6771. On the electrical conductivity of some alkaline earth titanates. E. K. WEISE AND I. A. LESK *J. chem. Phys.*, **21,** 801–6 (*May*, 1953).

The compounds Mg_2TiO_4, $MgTiO_3$, $MgTi_2O_5$, $CaTiO_3$, $SrTiO_3$ and $BaTiO_3$ were prepared in crystalline form by reactions in the solid state. The rod-shaped samples were sintered in oxygen at 1450°C and reduced in hydrogen at temperatures from 560°C to 1400°C producing *n*-type semiconductors. Resistivity values from 10^{-1} to 10^8 Ω.cm at 25°C were obtained. Reductions of about 3% by weight could be given the most reduced magnesium titanates while the largest reduction obtainable in $CaTiO_3$, $SrTiO_3$, or $BaTiO_3$ was less than 0·25%. The logarithm of resistivity was plotted *v.* reciprocal absolute temperature and showed a linear dependence in most cases over a wide range of temperature and resistivity. The curves for $BaTiO_3$ changed their slope abruptly at approximately 115°C, probably attributable to the crystal structure change at the Curie temperature, about 120°C. The dependences of

purity activation energy and Fermi level on per cent duction were determined for the case of Mg_2TiO_4. he Biltz–Meyer rule, stating a linear relationship of purity activation energy with resistivity at a ference temperature, was not obeyed over the large nge of reductions obtained. A.

537.311.32 : 539.23

772. Electron currents in thin oxide films on luminium. A. CHARLESBY. *Proc. Phys. Soc. ondon*] *B*, **66**, 533–41 (*July*, 1953).

At electric fields lower than those required to ause an appreciable ion current to flow, an electron urrent is observed in thin films of oxide formed on luminium in suitable electrolytes. The relationship etween electron current i_- and the field F across the m is represented by the equation $i_- = A_- \sinh B_- F$ here A_-, B_- depend on the temperature and on the arrier dimensions opposing the current. These latter re found to be about 0·61 eV and 1·4 Å. A similar ormula also holds for tantalum. Taken together ith the equation for ion current published previously Abstr. 5125 (1953)], this equation represents the ntire current over a range of some 10^4 to 1. The resence of trapped electron charges in the oxide yer near the electrolyte surface is discussed. A.

537.311.33

773. On new semiconducting compounds. II. H. WELKER. *Z. Naturforsch.*, **8a**, 248–51 (*April*, 953) *In German.*

Electrical conductivity-temperature and current-oltage curves are presented, the former for the ompounds InSb, GaSb, AlSb, the latter for AlSb, GaSb, GaAs, InP. A simple transitor characteristic as also been given for InP. These compounds are ll seen to be semiconductors, and belong to the roup *AB* where *A* belongs to the third, *B* to the ifth, group of the periodic table, as discussed pre-iously [Abstr. 3298 (1953)]. The gap widths are ·53 (InSb), 0·82 (GaSb), 1·65 (AlSb) eV, as inferred rom the conductivity measurements. P. T. LANDSBERG

537.311.33

774. Semiconducting compounds of boron with arbon and aluminium. J. LAGRENAUDIE. *J. Chim. hys.*, **50**, 352–5 (*May*, 1953) *In French.*

The semiconducting behaviour of the borides $B_{12}Al$ and B_4C, and of the borocarbide of Wohler as been studied by photoconductivity, variation of esistance with temperature, and the transparency in isible and infrared radiation. The results obtained re graphically presented, the energies of activation f the three compounds being 0·7 eV for B_4C, ·7 eV for $B_{12}Al$ and 2·4 eV for the borocarbide. G. I. W. LLEWELYN

537.311.33

775. Electron spin resonance in a silicon semi-onductor. A. M. PORTIS, A. F. KIP, C. KITTEL AND W. H. BRATTAIN. Letter in *Phys. Rev.*, **90**, 988–9 (*June* 1, 1953).

An electron spin resonance in the 9000 Mc/s range is reported for powdered *n*-type silicon containing 10^{18} P atoms/cm³ dispersed in paraffin wax, a temperature range of 4°K–300°K being investigated. The g factor is $2·001 \pm 0·001$. No saturation is found, indicating a spin/lattice relaxation time at 4°K of less than 10^{-3} sec. Line width increases markedly with temperature from 2 oersteds at 4°K to 35 oersted at 300°K (theoretical width with spins at rest is 0·1 oersted). Variation of susceptibility with temperature gives electron concentration of order of P concentration, and paramagnetic degeneracy is shown at about 38°K (theoretical 56°K) from which the effective electron mass is $1·5\ m_e$ in agreement with mobility data for bulk polycrystalline silicon. G. F. J. GARLICK

537.311.33

6776. Chemical effects due to the ionization of impurities in semiconductors. H. REISS. *J. chem. Phys.*, **21**, 1209–17 (*July*, 1953).

A theoretical account of the possible effects which the ionization of donor and acceptor impurities can induce in the thermodynamic phase relations involving their solutions with semiconductors. These effects reflect the energy band structure of the semiconductor. Furthermore, the phenomenon has an interest of its own, for within a certain range of experimental conditions the effects can be attributed to a chemical-like, mass action behaviour of the electrons which play the roles of negative ions. A fine point concerning the Fermi level is briefly discussed. It is shown that although the Fermi level is certainly the electronic electrochemical potential, it is not the Gibbs free energy per electron unless the density of electron energy levels is linear in the volume of the system. A.

537.311.33

6777. Experimental confirmation of relation between pulse drift mobility and charge carrier drift mobility in germanium. M. B. PRINCE. *Phys. Rev.*, **91**, 271–2 (*July* 15, 1953).

Experimental data of drift mobilities of minority carriers in germanium are brought into agreement with theoretical predictions by distinguishing between group velocity and particle velocity of a pulse of minority carriers. Corrected high temperature measurements of electron drift mobility are consistent with the theoretical prediction $\mu = AT^{-\frac{3}{2}}$. The experimentally determined value of A is $2·0 \times 10^7$ cm² deg$^{\frac{3}{2}}$/V sec. A.

537.311.33

6778. The transport of added current carriers in a homogeneous semiconductor. W. VAN ROOSBROECK. *Phys. Rev.*, **91**, 282–9 (*July* 15, 1953).

Taking into account the thermal equilibrium minority carrier concentration and employing the formulation which includes, as one of two fundamental differential equations, the continuity equation for added carrier concentration Δp, this equation is derived in a form which exhibits the ambipolar nature of the diffusion, drift, and recombination mechanisms under electrical neutrality. The general concentration-dependent diffusivity is given. The local drift velocity of Δp has the direction of total current density in an *n*-type semiconductor and the reverse in a *p*-type semiconductor, differing in general in both magnitude and direction from the minority-carrier drift velocity. Specifying a model for recombination fixes the dependence of a lifetime function

for Δp on Δp and the electron and hole mean lifetimes. Negative Δp, or carrier depletion with electrical neutrality, may occur. For known total current density, the continuity equation alone suffices, as for the case of $|\Delta p|$ small, for which the equation is linear. A condition for this comparatively important case is derived, and theoretical relationships are given, with the aid of a parameter specifying the Fermi level, which determine for germanium the minority carrier-Δp drift velocity ratio as well as the ambipolar diffusivity and group mobility in terms of resistivity and temperature. A.

537.311.33

6779. Electro-thermal behaviour of point contacts to semiconductors. A. D. STUCKES. *Proc. Phys. Soc.* [*London*] *B*, **66**, 570–87 (*July*, 1953).

The heating effects that occur when a current is passed through a point contact to a semiconductor which has no barrier layer, have been investigated. The d.c. volt–current curve has been calculated for three different activation energies, 0·60, 0·48 and 0·34 eV of the semiconductor with a tungsten contact. The change with frequency of the impedance of the contact to a small sinusoidal ripple, superimposed upon a steady current, has been calculated for an activation energy 0·60 eV. Both these calculations provide a means of estimating the radius of the contact. Experimental d.c. and a.c. characteristics have been obtained for tungsten in contact with disks of sintered magnesium titanate (Mg_2TiO_4) of appropriate activation energies. Fairly good agreement is obtained between the values of the contact radius calculated from the d.c. and a.c. experiments, and between the calculated and measured variation with frequency of the impedance to the sinusoidal ripple. To explain minor anomalies in the d.c. characteristic it is assumed that field emission occurs around the contact. A.

537.311.33

6780. Injected absorption in germanium. A. F. GIBSON. *Proc. Phys. Soc.* [*London*] *B*, **66**, 588–96 (*July*, 1953).

When minority carriers are injected into germanium the density of current carriers is increased. This forms the basis of transistor action. The increased number of carriers is expected to cause increased absorption in the infrared region of the spectrum. This effect has been observed and studied as a function of wavelength, injected current, frequency and other relevant parameters. The basic theory of the effect is discussed and is found to be substantially in agreement with the experimental results. Possible practical applications of the effect are described. A.

537.311.33

6781. The theory of electronic conduction in polar semi-conductors. D. J. HOWARTH AND E. H. SONDHEIMER. *Proc. Roy. Soc. A*, **219**, 53–76 (*Aug.* 11, 1953).

The Boltzmann equation is set up for the conduction electrons in a crystal in which the scattering is due to the polarization waves of the lattice, and it is pointed out that at low temperatures it is impossible to define a unique time of relaxation for the scattering process. The Boltzmann equation is solved by mes of a variational method, and exact expressions for electrical conductivity and the thermo-electric pov are obtained in the form of ratios of infinite det minants. By approximating to the exact solutio relatively simple expressions are derived which used to discuss the dependence of the conducti phenomena upon the temperature and upon degree of degeneracy of the electron gas.

537.311.33 : 535.3

6782. Optical and electrical properties of Zn single crystals with excess Zn. E. SCHAROWSK *Z. Phys.*, **135**, *No.* 3, 318–30 (1953) *In German.*

Needle shaped, and in some cases plates and pla like, single crystals of ZnO have been obtained evaporation. Using an atmosphere of mixed oxyge nitrogen and hydrogen, and a simultaneous evapor tion of Zn metal from a side furnace, clear crysta were obtained containing an excess of Zn whi could be varied by control of the temperature of t Zn evaporating furnace. Absorption and co ductivity measurements were made on the yello crystals so formed. Band maximum at about 3·2 e half width 1 eV. The uncoloured crystals (containi excess Zn) have a conductivity of 5×10^{-3} ohm^{-1} cm and conductivities up to 20 ohm^{-1} cm^{-1} have bee obtained with the coloured crystals. There is th usual straight line relation between log conductivit and reciprocal of temperature but the slope change at about a conductivity of 0·4 ohm^{-1} cm^{-1}, having metallic gradient above this. It is considered tha the conduction electrons are derived from Zn ion and that at the concentration corresponding to th above conductivity (0·4 ohm^{-1} cm^{-1}) all the exces Zn is ionized to Zn^+. J. EWLE

537.311.3

6783. The barrier mechanism of selenium rectifiers S. POGANSKI. *Z. Phys.*, **134**, *No.* 4, 469–82 (1953 *In German.*

The rectification properties of Se rectifiers using fiv different metals for the counter-electrode are found to be in general agreement with the Mott–Schottky model so long as any intermediate layer is carefully excluded during manufacture. The rectification depends markedly on counter-electrode material. I an intermediate layer of CdSe (*n*-type) is deposited the rectifying characteristics are indicative of a p–n junction and are relatively independent of counter-electrode material. C. A. HOGARTH

537.311.33 : 539.217

Diffusion of lithium into germanium and silicon. *See Abstr.* 7196

537.311.33 : 548.736.3 : 536.413 : 536.631 : 538.222

Study of the development of some properties of vanadium oxide in the neighbourhood of its transformation temperatures. *See Abstr.* 6951

537.311.33

6784. Study of the potential barrier separating two electrodes of the same metal at different potentials. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **236**, 1538–40 (*April* 20, 1953) *In French.*

The calculation of the tunnel effect for such contacts is outlined. C. A. HOGARTH

537.311.33 : 621.314.63

785. Dynamical theory of dry rectifiers. I. Limits application of the static theory. A. I. GUBANOV. *n. tekh. Fiz.*. **22**, *No.* 11, 1803–13 (1952) *In Russian.*

The limits of application of the static theory of y rectifiers previously suggested by the author [bstr. 8732 (1951), 6048 (1953)] to the case of a ctifier operating on a.c. of a few volts amplitude, e determined by analysing the equations of unsteady ffusion. It is found that the frequency has, above l, an effect on the establishment of equilibrium tween the numbers of mobile and fixed charges, is effect being appreciable already at the commercial equency of 50 c/s. The redistribution of the mobile arges in the barrier layer is, however, independent frequency up to $\sim 10^6$ c/s. B. F. KRAUS (R)

537.311.62

786. The effect of relaxation on microwave measurements of the anomalous skin effect. R. G. CHAMBERS. *hysica*, **19**, 365–70 (*April*, 1953).

In using anomalous skin effect measurements at icrowave frequencies to estimate the parameter σ/l, has generally been assumed that relaxation effects ould be neglected. Dingle's new calculations [Abstr. 6787–8 (1953)] make it possible to check this ssumption, and to give methods of detecting the ffects if they are appreciable. It is found that for ormal metals the effects are small at frequencies up 20 000 Mc/s, but that for bismuth they are large nough to reduce the estimate of σ/l from its previous alue, $2{\cdot}74\times10^7$ ohm^{-1} cm^{-2}, to $1{\cdot}53\times10^7$ ohm^{-1} m^{-2}. A.

537.311.62 : 535.137

787. The anomalous skin effect and the reflectivity f metals. I. R. B. DINGLE. *Physica*, **19**, 311–47 (*April*, 1953).

It is shown that considerable simplifications may e effected in some of Reuter and Sondheimer's [Abstr. 2123 (1948)] formal expressions for the lectric field in a metal when the skin effect is nomalous. The formal solutions for the surface npedance are evaluated without recourse to direct umerical integration. Special attention is paid to he optical regions, where the results assuming diffuse eflection of electrons at the metallic surface are found o be quite different from those assuming specular lectron reflection: in particular, the optical absorptivity of metals assuming diffuse electron reflection s especially for good conductors at low temperatures, nuch greater than that calculated on the assumption f specular electron reflection, or that calculated by sual standard theory ignoring the anomalous nature f the skin effect. Tables are constructed of the surface esistance and reactance in the microwave region for oth specular and diffuse electron reflection, and in he infrared for diffuse electron reflection. Explicit ormulae are derived for the optical properties of netals in the near infrared, visible and ultraviolet, oth for specular and for diffuse surface reflection f electrons. A.

537.311.62 : 535.137

788. The anomalous skin effect and the reflectivity f metals. II. Comparison between theoretical and experimental optical properties. R. B. DINGLE. *Physica*, **19**, 348–64 (*April*, 1953).

It is shown that the observed optical properties of metals are in much better agreement with theoretical values taking into account the anomalous nature of the skin effect and assuming diffuse reflection of electrons at the metallic surface than with those assuming specular electron reflection, and in discord with the predictions of standard theory ignoring the anomalous nature of the skin effect. The metals discussed are Na, Cu, Ag, Au, Pt, W, Al, Pb and Sn, principal attention being paid to the infrared, so as to avoid complications due to the photoelectric absorption bands normally present in the visible and ultraviolet. Suggestions are made for future experimental work. A.

537.312

6789. Chemical aspect of the electrical conductivity of metals and alloys. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **236**, 1643–5 (*April* 27, 1953) *In French.*

A re-examination of the effects of alloying on the residual resistance and the temperature coefficient of resistance in the system Cu/Al. C. A. HOGARTH

537.312.5

6790. On the problem of dark currents in photomultipliers. N. SCHAETTI AND W. BAUMGARTNER. *Z. angew. Math. Phys.*, **4**, *No.* 2, 159–60 (1953) *In German.*

The dark current in photomultipliers increases on irradiation and decays slowly in the dark. Studies on Li–Sb and Cs–Sb surfaced tubes shows that the increase saturates with light intensity. Irradiation increases also the response to red light which also decays slowly in the dark. The latter decay accelerates with increase in red light irradiation. The effects are similar to those found in photoconductive cells and crystal phosphors. G. F. J. GARLICK

537.312.5

6791. The photoeffect in a homogeneous electric field. H. ÜBERALL. *Acta phys. Austriaca*, **7**, *No.* 1, 14–22 (1953) *In German.*

The change, due to the presence of a homogeneous electric field, in the angular distribution of the photoelectrons and in the total cross-section is calculated by the methods of the time-dependent perturbation theory. The effect appears to be too small to be detected experimentally. L. PINCHERLE

537.312.5

6792. Experiments on the variations of photoconductivity of CdS crystals on irradiation with X-rays, and the manufacture of a vacuum CdS crystal cell used as a dosemeter employing a new technique. H. SIMON. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 45–56 (1953) *In German.*

By maintaining CdS crystals in a highly evacuated enclosure the changes of conductivity on X-irradiation can be made very constant and reproducible. This suggests a method of measuring X-ray intensities and miniature test cells and a complete equipment utilizing CdS crystals are described in detail. C. A. HOGARTH

537.312.5

6793. Some attempts to interpret the laws governing the behaviour of photopiles. G. Blet. *J. Phys. Radium*, **14**, 241–50 (*April*, 1953) *In French.*

An attempt is made to explain the known characteristics of selenium photovoltaic cells. The chief interest is in the function of the barrier layer. Quantitative treatment is given using classical theory.

G. F. J. GARLICK

537.312.5

6794. Temperature, current, magnetic field phase diagram of superconductivity. W. Meissner, F. Schmeissner and H. Meissner. Letter in *Phys. Rev.*, **90**, 709 (*May* 15, 1953).

It is pointed out the failure of Mendelssohn, Squire and Teasdale [Abstr. 8215 (1952)] to confirm the authors' paramagnetic effect in the transition region in the presence of a current above a minimum value J_0 [Abstr. 1806–7 (1952)] is due to the fact that their current was actually $<J_0$. H. LONDON

537.312.5

6795. The paramagnetic effect in superconductors. T. S. Teasdale and H. E. Rorschach, Jr. Letter in *Phys. Rev.*, **90**, 709 (*May* 15, 1953).

See preceding Abstr. Repetition of the experiments of Abstr. 8215 (1952) with higher currents confirms Abstr. 1806–7 (1952). H. LONDON

537.312.5

6796. Photoelectric cells for the vacuum ultraviolet. H. E. Hinteregger and K. Watanabe. *J. Opt. Soc. Amer.*, **43**, 604–8 (*July*, 1953).

The photoelectric effect on Ni, Pt and W has been used in the design of windowless phototubes for the direct detection of radiation in the vacuum ultraviolet, especially of wavelengths below the transmission limit of LiF. Yields were found to be as high as 10 photoelectrons per 100 incident quanta for the wavelength region below 1000 Å. Good preliminary results were obtained with these tubes: extremely high quantum yields, reproducibility after exposure to air and adjustability of the spectral response by the external circuit. A.

537.312.5

6797. The photoelectric constants of iodine. D. C. West. *Canad. J. Phys.*, **31**, 691–701 (*July*, 1953).

The retarding-potential method of photoelectric measurement has been applied to the determination of the work function and energy gap of a typical molecular crystal. Three allotropic forms of solid iodine, believed to be amorphous, monoclinic and rhombic, have work functions of 6·8, 5·4 and 2·8 eV respectively, and photoelectric thresholds of 1880, 2050 and 2360 Å. The energy gaps of the crystalline modifications are 0·6 and 2·5 eV. A.

537.312.5 : 621.383.5

6798. The infrared sensitivity of copper oxide photocells fabricated under a reduced pressure in a field of high frequency current. A. I. Andrievskiĭ and A. L. Rvachev. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 245–7 (1953) *In Russian.*

The process of fabrication of the cells is described. By varying pressure, temperature and time, cells with diverse properties can be produced. Spectral characteristics of different cells are shown, some with a front effect in the green and a back effect in the red, and c with a front effect in the green, red and infra regions of the spectrum. These are discussed in ter of reduction of a surface layer of cuprous oxide virgin copper which controls the sensitivity, increase in the reduction leading to increased ser tivity in the infrared. Similar work was first done reduction in solution. W. BARDSL

537.312.5 : 77

6799. Silver bromide polycrystalline film prepared precipitation method for photoconductive measu ments. M. Tamura and S. Tutihasi. Letter *J. Opt. Soc. Amer.*, **43**, 407–8 (*May*, 1953).

537.312

6800. Method of rapid determination of the ter perature-conductivity coefficient of solids and liquid V. P. Zhuze and A. R. Regel'. **Appendix.** A. Gubanov. *Zh. tekh. Fiz.*, **22**, *No.* 8, 1376– (1952) *In Russian.*

Describes a method based on the measurement the rate of temperature rise of a small-capaci receiver, due to a heat-flow passing through th specimen tested. The measurement is carried out b means of a differentiating transformer the use of whic was described by Markus, Pivovar and Podgorn [Abstr. 8997 (1951)]. The specimen is placed on hard-rubber, or Plexiglass, support, the surface which contains the hot ends of a thermocouple; i cold ends pass through massive copper cylinders an are connected to the primary coil of the transforme whose secondary coil is connected to a galvanomete The source of heat is a copper cylinder fitted wit another thermocouple. The specimen and suppor are first brought to a lower temperature by means c large copper beakers with cold water; these ar removed, and the heater is placed on top of th specimen; the temperature conductivity is deter mined by observing either the maximum deviatio of the galvanometer or the time required to attai this deviation, the former procedure giving mor accurate results than the latter. The proportionalit between deviation and temperature conductivity i observed only within a certain conductivity range fo a specimen of given dimensions. Calibration curve for different shapes and sizes of specimens have bee obtained, using Cu, Pb, (Armco) iron, Hg, quartz glass and H_2O as standard substances. For liquids a thin-walled cylinder without bottom is placed on top of the specimen cylinder and filled with the liquid tested. Temperature conductivity values have been measured for many solids and liquids. Results are tabulated of measurements on 4 steels (annealed and hardened). In the appendix, Gubanov derives theoretical expressions for the maximum rate of tem perature increase. F. LACHMAN

537.312.62

6801. Superconductivity. D. Shoenberg. *Cambridge: University Press* (1952) x + 256 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66**, 775 (*Aug.*, 1953).

537.312.62

6802. The superconductive transition in lead. H. Preston-Thomas. Letter in *Canad. J. Phys.*, **30**, 626–7 (*Sept.*, 1952).

Lead exhibits a practically discontinuous magnetic

nsition, but the resistance transition covers a range magnetic field the extent of which varies both with temperature and the measuring current. This is nilar to the behaviour of Nb and Ta.

537.312.62

03. Is a superconductor free from noise? K. S. NOL AND J. VOLGER. *Physica*, **19**, 46–50 (*Jan.–Feb.*, 53).

From measurements at 6 Mc/s it is concluded that extra noise is generated in a ring of NbN when s ring is brought into a superconducting state, en when a persistent current of about 100 A is cited. A.

537.312.62

04. Interpretation of electric current in wave and antum mechanics. G. POCHOLLE. *Bull. Soc. Franç. ect.* (*Sér.* 7) **3**, 143–59 (*March*, 1953) *In French.*

A tentative qualitative explanation of the variation transition point with frequency for superconductors, sed on quantum interaction between the waves d the thermal electrons in the conductor, is given. ne author also suggests a relation between resis- vity and specific heat, which appears to accord ith practical curves for some metals. G. D. SIMS

537.312.62

05. Low temperature diamagnetism of electrons a cylinder. W. BAND. *Phys. Rev.*, **91**, 249–55 *uly* 15, 1953).

The exact eigenfunctions are found for an electron a cylindrical container in the presence of a uniform xial magnetic field. The eigenvalue spectrum, while perficially similar to that in free space, is so essen- ally different that the statistical properties of an ectron assembly in the cylinder are entirely different om those derived in previous work. It is therefore f interest to use an integration approximation in mputing the energy of the assembly at 0°K. It rns out to have a very strong size-dependent para- agnetic term, and the reasons for this are carefully xplained. The work lends support to the view that ne observed diamagnetism of electrons in the super- onducting state cannot be understood in terms of ny free electron approximation, and that interactions vith the lattice potential play an essential role. A.

537.312.62

806. The phase transition in superconductors. I. Phase propagation above the critical field. T. E. ABER. *Proc. Roy. Soc. A*, **219**, 75–88 (*Aug.* 11, 1953).

For Pt I, see Abstr. 8216 (1952). Detailed measure- ents have been made of the rate at which the super- onducting phase collapses radially in cylindrical ods of tin, when they are suddenly subjected to a agnetic field greater than the critical. This is robably the simplest example of phase propagation n superconductors. The results in most respects onfirm the theory of Pippard [Abstr. 4096 (1950)] nd Lifshitz [Abstr. 1016 (1952)], according to which he propagation is controlled by an electromagnetic amping associated with the setting up of eddy urrents. This theory explains in detail the way in vhich the rate of propagation depends on specimen adius and conductivity, and on field strength; its nly failure is at the higher temperatures, where the agnitude of the rate of propagation tends to be slightly less than the theory predicts. Other factors besides eddy currents which might be retarding the transition are latent heat, the interphase surface energy, and a finite relaxation time governing the destruction of superconductivity by a magnetic field; but none of these proves altogether adequate to account for the discrepancy mentioned. The experiments provide evidence that the relaxation time is less than 0·2 μsec in tin. A.

537.312.8

6807. The Ettingshausen effect in Bi–Pb alloys. B. NEUMANN AND K. M. KOCH. Note in *Z. Naturforsch.*, **8a**, 331–2 (*May*, 1953) *In German.*

Reports room temp. measurements on poly- crystalline specimens with up to 10% Pb and in magnetic fields up to 7×10^3 oersted. Curves are given showing the variation of ΔT with H and also the variation of the Hall potential for different values of the Pb concentration. E. P. WOHLFARTH

537.312.8

6808. Conductivity of thin films in a longitudinal magnetic field. E. KOENIGSBERG. *Phys. Rev.*, **91**, 8–9 (*July* 1, 1953).

An integral expression for the electrical conductivity of thin films in a longitudinal magnetic field is derived by an analysis of free electron trajectories in the film. This is evaluated in the limit of strong magnetic fields. A.

537.312.8 : 536.48

6809. The magnetoresistances of alloys of a noble metal and a transition metal at low temperatures. A. N. GERRITSEN. *Physica*, **19**, 61–73 (*Jan.–Feb.*, 1953).

In continuation of the measurements in zero field [see Abstr. 8744 (1951)] the resistance of dilute alloys of copper and gold with manganese and chromium were measured in magnetic fields (up to 20 kOersted). The decrease of resistance of these dilute alloys seems to represent a general property of alloys such as manganese in copper, silver and gold, iron in gold, chromium in gold, and iron in magnesium. The latter cases are examples of a more complicated behaviour. A comparison of the results of resistance measurements at low temperatures leads to the following classification of the alloys: (1) Alloys with electrical resistance independent of temperature and magnetoresistance changing according Kohler's rule. (2) Alloys with a minimum in the zero-field resistance and no deviations from Kohler's rule. (3) Alloys with a maximum (and consequently a minimum) in the zero-field resistance and a decrease of resistance in a magnetic field. A.

537.32

6810. Thermoelectric e.m.f. in a monometallic circuit. H. BENEL. *Rev. Fac. Sci. Univ. Istanbul, A*, **18**, 65–78 (*Jan.*, 1953) *In French.*

Thermoelectric e.m.f.'s due to inhomogeneity in the orientation of the metallic crystals, or to occluded gases, disappeared in time, and could be removed by heating, but e.m.f. due to heterogeneity in geometrical form remained. The existence of e.m.f.'s in absence of all such heterogeneity was not definitely established. P. M. DAVIDSON

537.36

6811. A note on the evaluation of true zeta-potential of colloidal particles in the presence of equi-coagulating concentration of different electrolytes. B. N. GHOSH AND S. C. RAKSHIT. Letter in *Sci. and Culture*, **18**, 498–9 (*April*, 1953).

It has been found experimentally that the reciprocal of the zeta-potential of a TiO_2 sol (in the presence of various electrolytes in concentrations of equal coagulating power) varies linearly with the reciprocal of the specific conductivity of the supernatant solution in contact with the coagulum. This finding is in agreement with the theory of Elton [Abstr. 2364 (1948)]. The true zeta-potential as calculated from the observed zeta-potential and specific conductivity remains fairly constant. F. LACHMAN

ELECTRIC DISCHARGES 537.52

537.521

6812. Formative time lags in the electrical breakdown of gases. J. DUTTON, S. C. HAYDON AND F. LLEWELLYN JONES. With a mathematical appendix by P. M. DAVIDSON. *Brit. J. appl. Phys.*, **4**, 170–4 (*June*, 1953).

The time rate of growth of ionization currents in a gas in a uniform electric field greater than that corresponding to the static sparking potential is investigated theoretically. This theoretical analysis is then applied to the breakdown of a gas at high values of the parameter *pd*. It is shown that the same primary and secondary ionization processes which lead to a growth of pre-breakdown currents in agreement with experiment, and to the calculation of static sparking potentials in agreement with those measured, also lead to a rapid decrease of the formative time lag with increasing overvoltage. The introduction of some other quite different process to account for the short formative time lag is unnecessary. The present theoretical investigation, together with previous experimental and theoretical studies, therefore, lay the basis of a comprehensive view of the electrical breakdown of gases covering a wide range of parameters. Curves showing the dependence of the formative time lag on overvoltage, calculated by means of the above analysis, are given; these curves may be used to elucidate the various secondary ionization processes operative in the breakdown mechanism. A.

537.521.6

6813. Cooling of fine wires in compressed air and application to pre-breakdown currents. A. BOULLOUD. *C.R. Acad. Sci.* [*Paris*] **236**, 1339–41 (*March* 30, 1953) *In French.*

The electrical resistance of a horizontal fine wire, about 13 cm long, along the axis of a 16 cm diameter enclosure has been measured as a function of current for air pressures of 1–40 kg/cm². The wire diameter *a* and its temperature were deduced from the resistivity and its temperature coefficient. The results agree with Langmuir's theory and the graph given shows that the rise in temperature of the wire for a given power dissipated depends only on (pa) where p is the density of the air. It is concluded that the local variations in density of a gas due to heating by pre-breakdown currents have a negligible effect on the spark voltage. S. WEINTRO

537.523.4 : 537.523

6814. High frequency gas discharge breakdown in neon. A. D. MACDONALD AND D. D. BETTS. *Can. J. Phys.*, **30**, 565–76 (*Sept.*, 1952).

Electrical breakdown of neon at high frequency has been treated theoretically on the basis of the Boltzmann transport equation. Exciting and ionizing collisions are accounted for as energy loss terms in the Boltzmann equation and measured values of the ionization efficiency are used in the integral determining the ionization rate. Electrons are lost to the discharge by diffusion. The equations are treated separately for the cases in which the collision frequency is much less than or much greater than the radian frequency of the applied field. The electron energy distribution functions are expressed in terms of Bessel functions, confluent hypergeometric functions and simple exponentials. The ionization rate and the diffusion coefficient are calculated using these distribution functions in kinetic theory formulas, and combined with the diffusion equation to predict breakdown fields. The theoretically predicted fields are compared with experiment at 3000 Mc/s. The breakdown equations, calculated from kinetic theory and using no gas discharge data other than collision cross-sections, predict breakdown electric fields within the limits of accuracy determined by these cross-sections over a large range of experimental variables.

537.523.

6815. The space charge zone at the [electrode] limit of an arc plasma. G. ECKER. *Z. Phys.*, **135**, *No.* 1, 105–18 (1953) *In German.*

Gives a theoretical investigation of the region near electrodes in a plasma, where appreciable resultant space charges may be found. The treatment is based on the early Langmuir theory of the cathode region of arcs, etc., but introduces the effect of an electron current, and it is discussed in relation to the work of Cobine and Gallagher, Froome, Somerville and others on cathode spots in transient arcs.

J. D. CRAGGS

537.523.5 : 537.53 : 535.89

The carbon arc as an infrared source. *See Abstr.* 6689

537.523.5 : 621.3.014.31

6816. On McPherson's graphite normal arc. J. EULER. *Z. angew. Phys.*, **5**, *No.* 2, 64–9 (1953) *In German.*

The energy distribution of the radiation in the graphite normal arc is affected by the blue CN bands; the total radiation is often increased by about 4%. Methods of eliminating this effect are discussed and the effect of CO_2, both stationary and flowing, of previous heating in CO_2, of boron in the anode, and of impurities liberated from the cathode are examined. F. LLEWELLYN JONES

537.525.3

17. Streamer mechanisms in a.c. "silent" discharges. S. R. KHASTGIR AND C. M. SRIVASTAVA. ...tter in *Sci. and Culture*, **18**, 487–8 (*April*, 1953).

A discussion of discharge mechanisms in low ...essure, high voltage a.c. ozonizer tube discharges.

J. D. CRAGGS

537.525.4

18. Some properties of hydrogen spark channels. ... D. CRAIG AND J. D. CRAGGS. *Proc. Phys. Soc. ...ondon*] *B*, **66**, 500–11 (*June*, 1953).

Measurements of voltage gradients and visible ...annel diameters for hydrogen sparks (100–200 A ...ctangular current pulses) at 1 atmosphere pressure, ...e described. The results are discussed in terms of ...e physical properties, such as the gas temperature, ... the channel. It appears from the drift current ...uation, on insertion of measured values of current ...d electron density, that the electron drift velocity ...s a constant-pressure (arc-like) condition for the ...annel better than a constant-density condition. ...he results are consistent with a channel temperature ...f about 15 000°K. Diffusion processes, in the later ...ages of spark channel expansion, are also discussed.

A.

537.525.5

819. Investigations on the electrode spot movement ...t the cathode of a low pressure mercury vapour arc, ...ith variations in observation time. G. STEER. *Z. ...ngew. Phys.*, **5**, *No.* 3, 116–19 (1953) *In German.*

Describes a method for the measurement of cathode ...ot size (diameter) and velocity of expansion as a ...nction of time after the striking, and gives detailed ...easurements. Currents range up to 600 A. Dis...ussion of the physical mechanisms is given, with ...eference to the earlier work of Smith, Rothstein, ...ongini and others on the influence of magnetic fields ...n spot behaviour, etc., and with special emphasis on ... simple diffusion process of expansion. J. D. CRAGGS

537.525.5

820. Probe studies of energy distributions and radial ...otential variations in a low pressure mercury arc. ...R. M. HOWE. *J. appl. Phys.*, **24**, 881–94 (*July*, 1953).

The electron-energy distributions showed de...letions from a Maxwellian distribution in the high ...nergy range. Coupling effects between adjacent ...robes were investigated and were found to be quite ...mall but in the proper direction to agree with the ...angmuir–Tonks theory. Drift-current distortion of ...he random electron-energy distributions was meas...ured with a bidirectional probe and compared with ...heory. A multisection probe extending from tube ...xis to tube wall allowed a determination of radial ...otential and density variations. Results over a ...ressure range from 3·4 microns to 35 microns ...howed good agreement with the ambipolar diffusion ...heory based on cumulative ionization. A direct ...alculation of ionization rate in the plasma was made ...rom the ionization probability for a one-step ionizing ...rocess; comparison of this calculation with the ...bserved ionization rate at 1·7 microns indicated that ...t that pressure the ionization is half direct, half ...umulative. For higher arc pressures cumulative ...onization evidently predominates. A.

537.525.6

6821. Dependence of Joshi effect on electronic part of the discharge current. N. A. RAMAIAH, M. G. BHATAWDEKAR AND N. SUBRAHMANYAM. *J. chem. Phys.*, **21**, 1160–5 (*July*, 1953).

Association of Joshi effect Δi with electronic part i_e of the discharge current i was investigated by elimination principle. i_e was suppressed under transverse magnetic field H. In agreement with Joshi's theory, negative effect (— per cent Δi) in water and iodine vapour was maximum in i and negligible in $i - i_e$; comparatively, positive effect was unaffected by H. A.

537.525.8

6822. The growth of the high frequency electrodeless discharge. G. FRANCIS AND A. VON ENGEL. *Philos. Trans A*, **246**, *No.* 909, 143–80 (1953).

This very comprehensive and detailed paper deals in two main parts (theoretical and experimental) with h.f. discharges, operated at frequencies varying from 10–20 Mc/s and at low pressures (2 to 35 microns) in electrodeless tubes whose dimensions are less than the mean free paths of electrons, in the given discharge conditions. The theoretical sections deal (*a*) with the starting condition, namely the need for secondary emission multiplication of the electrons at the tube walls which, in turn, necessitates the establishment of a certain electric field, and (*b*) the growth of the discharge current. The latter study involves detailed consideration of the effects of energy distributions, space charges, etc. The experimental section deals with a new balancing technique for eliminating capacity currents. Oscillograms of discharge current growth are given. J. D. CRAGGS

537.525.8

6823. On the production of hydrazine and ammonia in glow discharges. H. SCHÜLER AND V. DEGENHART. *Z. Naturforsch.*, **8a**, 251–5 (*April*, 1953) *In German.*

The rate of formation of NH_2–NH_2 and NH_3 in glow discharges is determined, using tubes 20–200 cm long and 1·5–5 cm in diameter. Discharge pressures were a few mm Hg. Supply frequencies of 50 and 500 c/s were used. The data for yields, etc., are tabulated and, typically, yields of $N_2H_4 \sim 8$ g/kWh were obtained. J. D. CRAGGS

537.525.8 : 535.33.03

6824. Vacuum tube molecular emission and dissociation spectra. J. H. LEE. Letter in *J. Opt. Soc. Amer.*, **43**, 619 (*July*, 1953).

Discusses the recent results of Talley, Lowe and Scanlon [Abstr. 1663 (1953)] on glow discharge excitation of band spectra by comparing them with earlier (1905) relevant work of Coblentz. J. D. CRAGGS

537.528

6825. The use of the mercury cathode in the dielectric breakdown of liquids. A. H. SHARBAUGH, J. K. BRAGG AND R. W. CROWE. Letter in *J. appl. Phys.*, **24**, 814–15 (*June*, 1953).

Impulse tests on benzene in a 0·084 mm gap between an Hg cathode and steel anode give highly reproducible breakdown values (about 1·4 MV/cm). Rectangular pulses of 1–20 μsec length cause only small deformation of the cathode (proportional to εE^2) and are easily corrected. J. H. MASON

537.529

6826. The electron avalanche in insulators under high electric fields. C. YAMANAKA AND T. SUITA. *J. Instn Elect. Engrs Japan*, **72**, 276–80 (*May*, 1953) *In Japanese.*

Electron avalanches induced in KCl, $CaCO_3$ (polar crystals), S (non-polar crystal) and glass have been measured, using apparatus of crystal counter type. Results seem to show that electrical breakdowns in solids occur through electron avalanches at high temperatures as well as at low. Origin and number of the initial electrons which will develop to avalanches are considerably influenced by temperature. These variations are closely related to the atomic structures and various space charges. As to the electron avalanches in an ionic crystal, KCl, at lower temperatures, those which are large in magnitude and few in number are dominant and cause the breakdown; at higher temperatures the more numerous, but smaller, avalanches chiefly contribute to the determination of breakdown. Under high electric fields, if the generating conditions of initial electrons are simplified, the distribution of electron avalanches can be expressed approximately by Furry's distribution. A.

X-RAYS 537.531

537.531

6827. The energy spectrum of the X rays from a 70-MeV synchrotron. I. B. MCDIARMID. *Canad. J. Phys.*, **30**, 670–83 (*Nov.*, 1952).

The spectrum of the X-rays produced in the forward direction by 70 MeV electrons striking a very thick target has been measured. The scattering method has been used to determine the energies of about 650 electron pairs produced by the X-rays in G-5 emulsions and from this the spectrum has been deduced. The number of photons found below 25 MeV is considerably less than that expected from the Bethe–Heitler–Schiff theory. No satisfactory explanation of this has been found but the measured spectrum is in agreement with "yield" measurements. A.

537.531 : 535.33.07

6828. Concerning the possibility of using ground calcite crystals as X-ray gratings. G. BROGREN. *Ark. Fys.*, **6**, *Paper* 46, 479–90 (1953).

Spacings and structure factors of 88 orders of reflection are tabulated. The unit cell dimensions were redetermined and are given as $a = 4980{\cdot}02 \pm 0{\cdot}03$ X.U., $c = 17\,025{\cdot}12 \pm 0{\cdot}10$ X.U. The perfection of calcite crystals was investigated [see also Abstr. 4410 (1953)], and a method of spectroscopy using two reflecting planes and not requiring the use of a circular scale [Kossel, *Ann. Phys.* [Leipzig] **26**, 533 (1936)] is described. A. R. STOKES

537.531 : 535.343 : 539.153

Calculations of *K* absorption edges in some heavy atoms. *See Abstr.* 7046

537.531 : 621.384.613

6829. Long X-ray pulses from the betatron. T. J. KEEGAN. *Rev. sci. Instrum.*, **24**, 472 (*June*, 1953).

X-ray pulses of 300 μsec and longer, with no reduction in intensity, were obtained at all energies from 22 MeV betatron by using a long, slowly-rising orbit displacing flux to move the orbit slowly to the targ Details of the expander circuit are given. The X-r pulses so produced had an energy spread of or $1{\cdot}5\%$, and the betatron duty cycle was $5\frac{1}{2}\%$.

537.531.

6830. Calorimetric measurements of the energy X-rays. Ionization of the air and of rare gases. N determinations of constants: Energy of formation of pair of ions, ϵ. Efficiency of fluorescence, μ_s. Amp tude of discontinuities of absorption, δ. M. H. TELLE PLASENCIA. *Ann. Phys.* [*Paris*] **8**, 169–201 (*Marc April*, 1953) *In French.*

After a theoretical introduction, the numerical da for the calculation of the energy efficiency of t incident radiation are discussed. Details are give of the experimental techniques for the determinatio of the total incident energy of the radiation used ar of the ionization currents produced in the gase examined. The values obtained for the variou constants are tabulated and compared with previous recorded data. G. I. W. LLEWELY

537.531.08 : 539.166.0

6831. Photovoltaic radiation detector. W. W SCHULTZ AND R. A. DEWES. *Nucleonics*, **11**, 49–5 (*May*, 1953).

The detector consists of a NaI(Tl) phosphor sand wiched between 2 photovoltaic cells, with a minera or silicone oil to provide optical contact. Result of measurements on the cell output current as function of dose rate for 140 kV X-rays and Ra, T and Co^{60} γ-rays and upon the directional dependenc of the detector are given. L. R. SHEPHERI

CATHODE RAYS . POSITIVE RAYS 537.533/.53

537.533 : 541.183

Investigation of the surface reaction of oxygen with carbon on tungsten with field emission microscope. *See Abstr.* 7256

537.533 : 621.384.62

6832. On a linear electron accelerator for 3–4 MeV. J. VASTEL. *C.R. Acad. Sci.* [*Paris*] **236**, 1343–5 (*March* 30, 1953) *In French.*

The 500 keV model [Abstr. 4422 (1951)] has been used to design a model of increased length (2·2 m). The injection takes place at 30 kV. 3·5 MeV acceleration has been obtained with 25 mA peak current (10 μA mean) for an h.f. power of 500 kW. Many other details of the operation are given.

A. H. W. BECK

537.533 : 621.384.62

6833. Axial motion of electrons in a linear accelerator with $\beta = 1$. J. SWIHART AND E. AKELEY. *J. appl. Phys.*, **24**, 640–3 (*May*, 1953).

Complete integrated solutions have been found in terms of elementary functions for the motion of an electron on the axis of a progressive wave linear accelerator with a constant wave speed, $\beta = 1$. The character of the solutions has been discussed and asymptotic relations found. Calculations have been

de for the third section of the Purdue linear elerator, in which the curves for the first two sec-ns where $\beta < 1$ have been extended. The energy ribution of the emergent beam was computed. was found possible to design a linear accelerator h constant wave-speed sections which, without liminary bunching, would produce a beam of ater homogeneity in energy than might have been pected. A.

537.533 : 621.385.032.21 : 621.385.833

34. The field emitter: fabrication, electron micro-py, and electric field calculations. W. P. DYKE, K. TROLAN, W. W. DOLAN AND G. BARNES. *ppl. Phys.*, **24**, 570–6 (*May*, 1953).

When a specially designed field cathode assembly s inserted in a commercial electron microscope ich was appropriately modified for the purpose, the ometry of the needle-shaped emitter was obtained m micrographs of several of its profiles at various ges of emitter fabrication and experimental use. n investigation of several methods of fabrication vealed that a smooth, simple and relatively stable ngsten emitter geometry resulted from a refinement the methods of Benjamin and Jenkins which com-nes the electrolytic etch and the smoothing action surface migration. The electric field at any point an emitter surface was calculated when the emitter ometry was precisely fitted with one equipotential rface from the family surrounding a charged, iso-ted sphere-on-orthogonal-cone. A theoretical sur-ce distribution of current density for a typical nitter was derived from the calculated field distribu-on and the wave-mechanical field emission theory. om this result was calculated a value of the emitting ea which was in good agreement with experiment. A.

537.533.1

35. The influence of magnetic impulses on the netic energy of electrons. L. KOLODZIEJCZYK. *C.R. cad. Sci.* [*Paris*] **236**, 1476–8 (*April* 13, 1953) *In ench.*

Derives a relation for the change of the kinetic ergy of an electron moving in a magnetic field due a sudden change of the magnetic field strength.

E. P. WOHLFARTH

537.533.72

36. Electron optics. O. KLEMPERER. *Cambridge: niversity Press* (1953) 471 *pp.* [*Cambridge Mono-raphs on Physics*].

An enlarged and completely revised version of the 939 edition, it covers the e.o. characteristics of a omprehensive range of applications, with practical ather than theoretical emphasis. Subjects include: araxial e.o., field plotting, ray tracing, types of e.s. nd mag. lenses, aberrations, space charge, emission ystems, "cylindrical" lenses, deflection focusing, iscellaneous applications. 600 refs. J. C. E. JENNINGS

537.533.72

37. Angular aberrations in sector shaped electro-agnetic lenses for focusing beams of charged particles. . G. JOHNSON AND A. O. NIER. *Phys. Rev.*, **91**, 0–17 (*July* 1, 1953).

The general expression for the second-order angular berration of sector-shaped electromagnetic lenses onsisting of superimposed uniform magnetic and radial electric fields used for the plane focusing of diverging beams of charged particles is derived. The result is applied to the special cases of pure magnetic and pure electric field lenses. The ion optics of a mass spectrometer employing sector electric and magnetic lenses in tandem and which has first-order velocity focusing and second-order angular focusing is obtained. A.

537.533.72 : 621.318.572

6838. A trochoidal analyzer for charged particles. B. CRASEMANN. *Rev. sci. Instrum.*, **24**, 470–1 (*June*, 1953).

Particles from a source move in trochoidal paths whose mean radius is independent of the particle energy, under the action of crossed electric and magnetic fields. Reversal of the magnetic field causes either positrons or electrons to be received by the detector (a scintillation counter). G. D. SIMS

537.533.72 : 621.385.833

6839. Space charge requirements in some ideally focused electron-optical systems. N. WAX. *J. appl. Phys.*, **24**, 727–30 (*June*, 1953).

A selected set of points on the trajectories of charged particles traversing an electron-optical system may be considered to be an object space, and another set an image space. Electron-optical lenses are said to be ideally focused if the transformation of the points in object space to those in image space is one to one and continuous. A necessary condition for ideal focusing is used to prove that a number of electron-optical systems require the presence of space charge in order to be ideally focused. Expressions for some ideally focused electron-optical lenses are given, in particular those for cylindrical lenses without space charge derived from spherical lenses with space charge. A.

537.533.72 : 621.385.833

6840. On the proportioning of small [electron] microscopes. E. KINDER. *Optik*, **10**, *No.* 4, 171–91 (1953) *In German.*

A thorough discussion of the problems involved in the design of a desk-type instrument for mass production at a relatively low price. Such instruments have not the full resolving power of the major instruments, but can be used by non-specialists for a wide variety of investigations. The author's instrument, using electromagnets for focusing and a stabilized h.f. power supply, is described. A. H. W. BECK

537.533.72 : 621.385.833

6841. Emission-microscopy surface imaging by means of electrons released by oblique ion bombardment. G. MÖLLENSTEDT AND H. DÜKER. *Optik*, **10**, *No.* 4, 192–205 (1953) *In German.*

Gives a description of an apparatus for surface examination in which an ion source is arranged to bombard the surface to be observed, from the side at an angle of 30°. The surface forms the cathode of an immersion objective at whose focal point a small aperture is located and the focusing coils of a conventional electron microscope are used to produce the final image. Resolving powers of 2000 Å have been attained. Some very striking examples of the pictures obtained are included. A. H. W. BECK (R)

537.533.72 : 621.385.833

6842. Aberrations of electron images of imperfect emitting cathodes. F. Bertein. *J. Phys. Radium*, **14**, 235–40 (*April*, 1953) *In French.*

The effect of surface irregularities in the cathode in an emission microscope is considered. The optical aberrations, astigmatism, field curvature and distortion are studied. In general astigmatism limits the resolving power but may be eliminated by the means suggested by the author [*Ann. Radioélect.*, **2**, 379–408 (1947); Abstr. 659 B (1948)] leaving only the aberration of revolution. A. H. W. BECK

537.533.72 : 621.385.833

6843. An external control of the spacing of the projector pole-piece elements of the RCA EMU electron microscope. F. W. Bishop and S. B. Elliott. Note in *Rev. sci. Instrum.*, **24**, 459–60 (*June*, 1953).

537.533.72

6844. A semicircular [focusing] permanent magnet beta-ray spectrograph [with uniform field] for photographic recording of conversion lines. H. Slätis. *Ark. Fys.*, **6**, *Paper* 41, 415–36 (1953).

Exptl details: wt of Alnico 91 kg, of Fe yoke 550 kg, dia. of β-trajectories 10–30 cm; ThB + C + C″ source on 25 μ Pt wire of 3 mm effective length; source strength 330 μC, exposure time 23 hr. A new method is described for precise measurement of the distance between source and photographic image of conversion lines. Precautions for highest resolution included temperature control of the permanent magnet. High absolute precision was not sought. The $\frac{1}{2}$-widths of the *F* and *I* lines were respectively 6·0 and $1{\cdot}8\times10^{-4} = \Delta(H\rho)/(H\rho)$. This broadening of the *F* line confirms Lindström's observation [Abstr. 1167 (1952)]. The *G* and *H* lines had $\frac{1}{2}$-widths of 3·9 and $4{\cdot}1\times10^{-4}$ and the I_α line $1{\cdot}2\times10^{-4}$. *F*, *G* and *H* lines all originate in *K*-shell and it is suggested that the broadening (80 eV) corresponds to the natural line width of γ-radiation from the *K*-shell. J. C. E. Jennings

537.533.72

6845. A semicircular permanent magnet beta-spectrograph for photographic recording of conversion lines. H. Slätis. *Rev. sci. Instrum.*, **24**, 464–7 (*June*, 1953).

Shorter version of the instrumental part of the paper reported in the preceding abstract.

537.533.74

6846. The scattering of fast positrons by nuclei. L. R. B. Elton and K. Parker. *Proc. Phys. Soc.* [*London*] *A*, **66**, 428–36 (*May*, 1953).

It is shown that the effects of finite nuclear size and radiative correction cause considerable modifications to the Mott formula for the cross-sections. An exact calculation of the phase shifts is carried through for a simple nuclear model and 20 MeV positrons scattered by gold nuclei. Two approximate phase shift calculations are made and the singularity occurring in the radial wave equation is investigated. The radiative correction for scattering from light nuclei is found to be the same as for electron scattering. A.

537.533.74

6847. The application of variational methods to atomic scattering problems. III. The elastic scattering of electrons by helium atoms. B. L. Moiseiwitsch *Proc. Roy. Soc. A*, **219**, 102–9 (*Aug.* 11, 1953).

The variational method of Hulthèn has bee applied to the elastic scattering of slow electrons l helium atoms, the effect of exchange being taken in account in calculating the zero-order phase shi Satisfactory agreement has been obtained with th results given by numerical integration of the integr differential equation determining the scattering whe the total wave function is taken to be complete antisymmetric. Even at very low electron energi (0·04 eV) the agreement with experiment is goo [For Pt II, see Abstr. 5996 (1952)].

537.533.75 : 539.16

6848. Radioactive charging through a dielectri medium. E. G. Linder and P. Rappaport. Lett in *Phys. Rev.*, **91**, 202 (*July* 1, 1953).

Beta-rays emitted from one electrode of a condense pass through the dielectric and are collected at th other electrode. The system charges up and maximu voltage of 6600 V is recorded for a polystyrene dielec tric. By changing the collector electrode back-scatte ing coefficients for the β-rays are determined fo several metals which agree with previously publishe data. G. F. J. Garlick

537.533.8 : 621.385.1

6849. A simple activation for BeCu multipliers F. J. Fitz Osborne. *Canad. J. Phys.*, **30**, 658–9 (*Nov.*, 1952).

A consideration of previous methods used in activating BeCu electron multiplier plates has resulte in the development of a simple inert gas treatmen using a minimum of apparatus and resulting in a total multiplication factor comparable to that obtaine by other treatments. A

537.533.8 : 778.34

6850. The energy loss of a fast charged particle by Čerenkov radiation. R. M. Sternheimer. *Phys. Rev.*, **91**, 256–65 (*July* 15, 1953).

The calculation of the Cherenkov loss in emulsion is discussed. The loss in traversing the AgBr grains is $2{\cdot}2\times10^{-3}$ MeV/g cm^{-2} which is small compared to the relativistic rise of the total ionization loss (0·12 MeV/g cm^{-2}). For gases the Cherenkov loss is somewhat larger, being 0·14 MeV/g cm^{-2} for He and 0·04 MeV/g cm^{-2} for O_2. The theory is in reasonable agreement with experiments on the grain count in emulsion and on the droplet count in a cloud chamber filled with O_2. For gases an approximate analytic expression for the Cherenkov loss is obtained. Values of the density effect for 6 additional substances are presented. A.

537.533.9

6851. A formula for thick target bremsstrahlung. R. Wilson. *Proc. Phys. Soc.* [*London*] *A*, **66**, 638–44 (*July*, 1953).

Corrections to the Bethe–Heitler formula for thin target bremsstrahlung are calculated for the degradation of the electrons in a thick target by ionization and radiative losses. The calculations apply only to the cross-section integrated over all angles, and the accuracy of the formulae is discussed. A.

537.533.9:621.396.616

52. Experiments on radiation by fast electron ums. H. MOTZ, W. THON AND R. N. WHITEHURST. *appl. Phys.*, **24**, 826–33 (*July*, 1953).

The results of some experiments on mm wave and ht generation by means of an undulator are scribed. After a brief survey of the theoretical ckground the design of a magnet system is discussed. experiment is described in which a 100 MeV ctron beam from the Stanford linear accelerator ssed through the undulator. Light radiated by the am was observed and the plane of polarization termined. A small linear accelerator with good nching was used for an experiment on mm wave neration. At a beam energy of 3 MeV, radiation a wavelength band below 1·9 mm was observed. peak power output of the order of one watt was tained. Millimeter waves generated in the accele- tor tube were also observed. A.

537.534

53. The production of strongly luminous canal rays. GEBAUER AND E. KREYSZIG. *Z. Phys.*, **135**, *No.* 3, 9–60 (1953) *In German.*

The light intensity from hydrogen canal rays was vestigated as a function of the experimental con- tions, both for an all-metal canal ray tube with ion cusing, and for a glass tube of conventional design th equal tube and canal dimensions. The all-metal be was found to give approx. twice the light density the glass tube. J. HUGHES

537.534

54. On the technique of monochromatization of ion beam from an accelerator. H. BRUCK. *J. Phys. adium*, **14**, 251–6 (*April*); *Erratum*, 344 (*May*, 1953) *French.*

The conditions required for optimum performance a monochromator are considered. While a beam om an H.T. set is assumed, beams from other celerators could also be handled. The relations tween analysed current, degree of resolution and mensions of the apparatus, are found for deflecting d focusing fields of different orders of aberration. he types of instrument are considered without dis- ssion of mechanical detail or of the experimental ethods by which particular orders of aberration are hieved. The practical advantages of an electro- atic system with radial field and with a preliminary w-resolution magnetic analyser to remove the bulk the unwanted beam are shown. Numerical amples are given to show the performance to be pected of two particular types of monochromator. J. H. FREMLIN

537.534

55. The principles of the theory of motion of ions linear accelerators. M.-Y. BERNARD. *C.R. Acad. ci.* [*Paris*] **236**, 1655–7 (*April* 27, 1953) *In French.*

The inadequacy of the theory of electron linear celerators when applied to the non-relativistic celeration of positive ions is pointed out. Mathe- atical expressions are set up to represent the move- ent of an ion moving with constant phase with spect to the accelerating wave. Numerical calcula- ons show satisfactory agreement with the experi- ental results obtained from the early accelerator of Sloan for mercury ions and from the recent proton accelerator of Alvarez. J. H. FREMLIN

537.534

6856. On the effects of magnetic defects in a strong-focusing cosmotron. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **236**, 1657–9 (*April* 27, 1953) *In French.*

The effect of azimuthal variations of n on the extent of the stability regions is examined mathematically. It is shown that, for $n = \pm 900$, a 2% variation of n from section to section would have the effect of reducing very seriously the width of the stable region for acceleration between two successive forbidden bands. An equation is given from which quantitative prediction can be made of the effect of any expected azimuthal variations of n during acceleration. See also abstract following. J. H. FREMLIN

537.534

6857. Effect of magnet inhomogeneities in the strong-focusing synchrotron. J. B. ADAMS, M. G. N. HINE AND J. D. LAWSON. Letter in *Nature* [*London*] **171**, 926–7 (*May* 23, 1953).

The effect of small radial or vertical displacements of successive magnet sections is considered. To ensure that particles complete one revolution, the r.m.s. value of such displacements must be less than $\frac{1}{3}$ mm, for a machine of radius 10^4 cm with 240 sections. The oscillations in successive revolutions have been studied using the ACE, and it is found necessary to hold tolerances to about 1/6 mm to avoid excessive build-up. Variation of n during acceleration will increase oscillation amplitudes much further, and coupling or other effects may also do so but have not been fully investigated. See also preceding abstract. J. H. FREMLIN

537.534

6858. Energy spectrum measurements of protons in the Harwell cyclotron. J. M. DICKSON AND D. C. SALTER. *Brit. J. appl. Phys.*, **4**, 175–6 (*June*, 1953).

The proton spectrum of the Harwell cyclotron has been measured by a method which uses the cyclotron magnet as a momentum analyser. For a maximum energy of 174 MeV, the width of the spectrum at half height was of the order of 10 MeV. Random variations of the spectrum shape were observed which were thought to depend on the ion source. A systematic variation of spectrum width with radio-frequency accelerating voltage was found. A.

537.534 : 621.384.62

6859. A portable 250-kilovolt accelerator. T. A. BERGSTRALH, K. L. DUNNING, E. DURAND, C. H. ELLISON, H. K. HOWERTON AND W. SLAVIN. *Rev. sci. Instrum.*, **24**, 417–19 (*June*, 1953).

A linear particle accelerator of compact design. The high voltage is provided by a commercial Cockcroft–Walton type voltage-multiplier supply. A magnetic-type ion source is used to supply a focused beam in excess of 300 microamperes. A.

537.534.7

6860. Ionization and excitation losses of charged particles of intermediate energies. J. NEUFELD. *Proc. Phys. Soc.* [*London*] *A*, **66**, 590–6 (*July*, 1953).

A method is outlined for determining energy losses of charged particles of intermediate energies, i.e.

which do not carry bound electrons and have velocities lower than the K shell velocity of the stopping atom. The "free collisions" and the "resonance effects" are separately evaluated. The number of electrons participating in free collisions was determined by using the Thomas–Fermi model for the stopping atom, and the energy loss was evaluated by means of the Rutherford formula. The resonance effects were calculated by means of an expression derived by Fermi which represents a much better approximation than the usual logarithmic formula. The stopping power of a few elements has been computed and the results compared with experimental data. A.

537.534.72

6861. Note on the resolving power of mass spectrometers. L. KERWIN. *Canad. J. Phys.*, **30**, 503–11 (*Sept.*, 1952).

In calculating the resolving power of a homogeneous field mass spectrometer, one must consider the dispersion and the beam width of the instrument. The latter is the sum of at least 10 components, which are discussed. Formulae giving the resolving power of three types of spectrometer of current interest are developed, as well as formulae for positioning the exit slits. A.

537.534.72

6862. A nuclear spectrometer for heavy particles. II. Performance and focusing properties. C. MILEIKOWSKY. *Ark. Fys.*, **7**, *Paper* 3, 33–46 (1953).

For Pt I, see Abstr. 4405 (1952). Graphs are given of exptl. field form. Spectra (e.g. α-rays from ThC) were investigated both using counters and using nuclear emulsion plates; line shapes are given. Comparison is made with the discontinuous sector field theory of Svartholm [Abstr. 8041 (1950)] and Judd [Abstr. 5880 (1950)]. J. C. E. JENNINGS

537.534.72

6863. A nuclear spectrometer for heavy particles. III. Astigmatic two-directional focusing in a nuclear spectrometer as a means of eliminating line broadening due to angular energy spread of transmutation particles. C. MILEIKOWSKY. *Ark. Fys.*, **7**, *Paper* 5, 57–68 (1953).

The motion of the centre of gravity in a nuclear reaction leads to variation of kinetic energy of the emitted particles with angle of emission; this causes serious line broadening in a stigmatic focuser if the principal direction of collection makes ~90° with the bombarding beam. But if the focusing is mildly astigmatic, this energy spread only causes a rotation of the focal line, which does not mar resolution. The solid angle collected is almost unaffected.

J. C. E. JENNINGS

537.534.72

6864. Method of determining mass spectroscope dispersion. J. MATTAUCH AND L. WALDMANN. *Z. Naturforsch.*, **8a**, 293–305 (*May* 1953) *In German.*

Even in the most carefully built [illegible] spectrograph, one cannot rely on the ideal [illegible]-scale when measuring isotopic weights with hig[illegible] precision, as is necessary for the calculation of nuclear binding energies. Instead, the actual mass-scale in the neighbourhood of a "line" of unknown mass (line on a photographic plate or peak of a curve recording voltage, etc.) has to be ascertained with the help of neighbouring lines of known masses simultaneously recorded and measured (dispersion lines). T[illegible] approximation of the mass-scale and the evaluati[illegible] of the unknown line can be done in a clear and gene[illegible] way by the use of Lagrange's method of interpolati[illegible] However, Lagrange's approximation without a[illegible] further assumption would not be sufficient if one h[illegible] at one's disposal only a few dispersion lines wid[illegible] separated, as is the case especially in the range [illegible] light masses. Here one has to make partial use [illegible] the knowledge of the ideal mass-scale; this is outlin[illegible] in detail for the special cases of one and of two d[illegible] persion lines. In certain cases one will have to use [illegible] to three dispersion lines. Furthermore, it is not suf[illegible] cient to ascertain the mass-scale with the help of [illegible] set of dispersion lines in a certain range of the pla[illegible] (or of the voltage, etc.) at a particular value of t[illegible] field strength of the deflecting magnet (or of a simil[illegible] parameter) in order to evaluate an unknown li[illegible] which subsequently has been brought into this ran[illegible] by varying the field strength; because the dispersio[illegible] of an apparatus depends always slightly on the fie[illegible] strength (e.g. on account of the unavoidable satur[illegible] tion phenomena of the iron). The order of magnitu[illegible] of this effect has been estimated from experiment[illegible] Finally, there is given an account of the ideal mas[illegible] scales of all existing mass-spectrographs, includin[illegible] recent precision mass-spectrometers and a discussio[illegible] of the methods of evaluation used up to the prese[illegible] time.

537.534.7[illegible]

6865. A needle valve type of variable gas leak fo[illegible] mass spectrometers. E. F. BABELAY AND L. A. SMIT[illegible] *Rev. sci. Instrum.*, **24**, 508–10 (*July*, 1953).

A high vacuum needle valve may be used as a[illegible] adjustable leak for regulating the flow rate of ga[illegible] samples to a mass spectrometer, when the valve [illegible] equipped with a wedge and lever system providin[illegible] very sensitive control of the needle position. Flo[illegible] through the leak is molecular at spectrometer pressure[illegible] but mass flow may be secured by inserting a capillar[illegible] tube between the sample and the leak. The leak ma[illegible] be closed completely, thereby simplifying the desig[illegible] of the sample inlet system. A.

537.534.7[illegible]

6866. Surface ionization source using multiple fila[illegible] ments. M. G. INGHRAM AND W. A. CHUPKA. *Rev sci. Instrum.*, **24**, 518–20 (*July*, 1953).

A new multiple filament surface ionization source has been developed for mass spectrometry which for several of the elements is many times more efficien[illegible] than the usual single filament surface ionization source. Emission from the source can be shifted from the oxide to the metal position or vice versa by appropriate adjustment of temperatures. Because of the high efficiency of the source it is possible to look at the sample during a number of successive evapora-tions. Use of this source should eliminate the necessity of using electron multiplier ion detection for some elements. A.

537.534.72 : 612.316.73

6867. The control and stabilization of the magnetic field for a mass spectrometer. N. T. VAN DER WALT. *Rev. sci. Instrum.*, **24**, 413–16 (*June*, 1953).

A method is described by means of which the magnetic field for a mass spectrometer is stabilized

within one part in 25 000 over a period of 30 min any value of flux density within its variable range 580 gauss to 9·3 kilogauss. A.

537.534.75

58. The energy loss of hydrogen, helium, nitrogen, d neon ions in gases. P. K. WEYL. *Phys. Rev.*, **91**, 9–96 (*July* 15, 1953).

The rate of loss of energy of protons, deuterons, ium, nitrogen and neon ions in the energy range of 0 to 450 keV has been measured in the gases drogen, helium, air and argon. The ions were sent ough a differentially pumped gas system and the rgy loss in the forward direction due to the gas s determined with an electrostatic analyser. The ults for protons agree with recent measurements at California Institute of Technology. At the same rgy, the stopping cross-sections are roughly the ne for neon and helium ions. The stopping power nitrogen ions is greater than that for neon ions the same energy by a factor ranging from 1·3 to 9, illustrating the importance of external electron nfigurations in determining stopping powers in the rgy region chosen. With the exception of hydrogen s, the cross-sections for the heavier ions follow a wer law. The dependence ranges from $E^{0\cdot33}$ to $E^{0\cdot59}$ pending on the gas and ion, with several of the rves following an $E^{\frac{1}{2}}$ power law. A.

537.534.75 : 778.34

69. General calculation of the range-energy ationship for particles in any emulsion or in a dium of any stopping power. Numerical application the Ilford C2 emulsion. L. VIGNERON. *J. Phys. idium*, **14**, 145–59 (*March*, 1953) *In French.*

After a brief review of previous methods of calating range-energy relationships, a general method calculating such relationships is described in detail. r particles of energy less than 1 MeV the range-rgy calculation is based on experimental energy s data. For energies greater than 1 MeV it is own that the rate of energy loss can be expressed a function of two parameters which can be calated in the range 13 MeV $> E >$ 1 MeV and hich are constant for $E >$ 13 MeV. The range-rgy relationship is obtained by the integration of ese theoretical energy-loss curves, only three experiental range-energy points are required to provide alues of the requisite constants. The range-energy ationship for protons in Ilford C2 emulsions has en calculated for $E = 0{\cdot}1$ MeV up to $E = 220$ MeV, d is in excellent agreement with published values. rmulae are given for obtaining the range-energy ationships for alpha particles, tritons and deuterons m the data for protons. A. C. COATES

537.534.8

70. On the reflection coefficient of positive lithium s striking a metallic surface and the energy spectrum the secondary electrons. G. COUCHET. *C.R. Acad. i.* [*Paris*] **236**, 1862–4 (*May* 11, 1953) *In French.*

Measurements with nickel and Duralumin surfaces ve been made, using apparatus described earlier bstr. 914 (1953)]. Reflection coefficients increase m $\sim 0{\cdot}03$ at 1 keV ion energy to $\sim 0{\cdot}2$ at 13 keV. e secondary electrons have energies between 0 and V, with maximum intensity in the region 0 to 5 V. J. J. WILKINS

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537.542

6871. Potassium ion currents of high density. G. A. BOUTRY AND G. PIÉTRI. *C.R. Acad. Sci.* [*Paris*] **236**, 1350–2 (*March* 30, 1953) *In French.*

A cylindrical diode with tungsten filament was enclosed in a tube containing potassium vapour. It was observed that, at a critical filament temperature T_c, the saturation current of positive ions increased abruptly from zero to some constant value. The dependence of the current and T_c on vapour pressure was investigated. Currents up to 70 mA/cm² were obtained. J. J. WILKINS

537.542 : 621.387

6872. Arc drop and deionization time in inert gas thyratrons. S. PAKSWER AND R. MEYER. *J. appl. Phys.*, **24**, 501–9 (*May*, 1953).

The energy balance is discussed and a semi-empirical equation for recovery time is derived; the discussion is based on diffusion alone without consideration of cumulative ionization and metastable states. Corroborating the theoretical considerations, measurements were made of arc drop and recovery time in thyratrons filled with mixtures of Xe with Ar, Ne and He. The spectral emission lines in these discharges were photographed in the visible range. It was found that the arc drop remained fairly constant down to low concentrations of Xe and then increased steeply. Lines of the gas other than Xe also appeared only at low concentrations of Xe. The recovery time is a monotone declining function of the mixture of the heavy and the light components. The spectral lines are tabulated. A.

537.542 : 621.385.1.029.6

6873. On the theory of an electron tube with a helical travelling wave. E. I. VASIL'EV AND V. M. LOPUKHIN. *Zh. tekh. Fiz.*, **22**, *No.* 11, 1838–42 (1952) *In Russian.*

A theoretical study is made of the effect of velocity scattering of the electrons in the beam on the region of existence of complex solutions to the equation of propagation and on the values of the propagation constant. The conditions for amplification are established. E. RABKIN

537.542

6874. The mechanisms of self-quenching Geiger counters. D. BLANC. Note in *J. Phys. Radium*, **14**, 260–9 (*April*, 1953) *In French.*

Gives a comprehensive review of the physical processes occurring, or thought to occur, in Geiger counters containing polyatomic or halogen gases. Properties of external cathode (Maze) counters are also considered. Topics discussed include: gas discharge mechanisms, secondary emission processes, molecular dissociation in counters, dead times, discharge propagation, pulse shapes, geometrical considerations and temperature effects. 102 references are given. J. D. CRAGGS

537.542

6875. The photosensitivity of glass self-quenching Geiger counters with external cathode. H. SCHWARZ. *Z. Phys.*, **134**, *No.* 5, 540–5 (1953) *In German.*

Effects due to the counter walls and to the enclosed

gas (volume effect) are distinguished. The latter is attributed to molecular oxygen ions. When raised to metastable states by light absorption the probability of oxygen molecules taking up electrons is increased. The wall effect is connected with the lowering of the work function of the surface by adsorption of hydrogen (from decomposition of the alcohol present).

G. F. J. GARLICK

537.542

6876. A study of the operation of external cathode counters: the influence of thermal treatment and the effect of water released from the glass. M. GRENON. *C.R. Acad. Sci.* [*Paris*] **236,** 1772–3 (*May* 4, 1953) *In French.*

Shows counting rate/voltage characteristics for certain counters of the Maze type, which demonstrate the partial obliteration of the plateau by baking.

J. D. CRAGGS

537.542

6877. Analysis of counter tube measurements. I. H. PUPKE. *Arch. tech. Messen, No.* 209 (*Ref. J*076–7) 135–8 (*June*, 1953) *In German.*

Lists useful formulae, such as those relating to cross-sections for ionization by particles or to energy loss by high-energy particles, which relate to particle measurements with counter tubes, etc. Particles discussed in this way include cosmic rays, neutrons, electrons and γ-rays. 91 references are given.

J. D. CRAGGS

537.542

6878. The measurement of radioactive carbon in gas counters. A. F. HENSON. *Brit. J. appl. Phys.*, **4,** 217–19 (*July*, 1953).

An a.c. coupled quench circuit is used to quench counters containing non-selfquenching carbon-dioxide–carbon-disulphide mixtures for the measurement of radioactive carbon as carbon dioxide. The counters operate reliably at quite high counting rates and continuous discharges do not occur. Plateaux 200 V or more long with slopes of about 2 to 4% per 100 V are obtained. Accurate corrections for resolving time loss can be made for counting rates up to at least 15 000 counts/min. A.

537.542

6879. Large thin-wall Geiger counter. T. T. SUGIHARA. R. L. WOLFGANG AND W. F. LIBBY. *Rev. sci. Instrum.*, **24,** 511–12 (*July*, 1953).

A new thin-wall Geiger counter of large area sensitive to soft β-radiation has been developed. The sensitive area can be as large as desired and the wall thin enough for C^{14} (2 mg/cm^2). The cylindrical geometry renders the counter especially suitable for accurate assays of large solid samples of low specific activity and low energy. A.

537.542 : 621.387.42

6880. Self-quenching parallel-plate vapour counters operated at voltages below the static breakdown voltage. J. CHRISTIANSEN. *Z. angew. Phys.*, **4,** *No.* 9, 326–9 (1952) *In German.*

Describes experiments with methylal and ethyl alcohol fillings in parallel-plate counters, with gap widths ~1 cm, in which the pre-breakdown avalanches produced with external irradiation (e.g. Ra γ-rays) are counted. Details of the amplifier and of counter characteristics, which show plateaus, are giv Electron movements give pulse rise times $<10^{-7}$ s

J. D. CRAG

537.

6881. Effect of high beta backgrounds on precis alpha counting. D. G. MILLER AND M. B. LEBOE *Nucleonics*, **11,** 28–31 (*April*, 1953).

Experiments, in which intense β-sources w introduced into a methane flow-type proportio α-counter, are described. It was found that β-radiation caused a decrease in the α-counting ra The effect is attributed to a fluctuation in the base l of the pulses, which was observed to occur in presence of the β-sources. L. R. SHEPHE

537.5

6882. On Maze counters. A. ARON. *Z. Phy* **134,** *No.* 5, 622–41 (1953) *In German.*

The properties of Maze counters, i.e. Geige Müller counters with cathodes external to the gl bulb, are discussed in considerable detail. C fillings of argon–alcohol are used. The characterist of normal and of Maze counters are directly compar using measurements made on both types of tu Plateau characteristics are given graphically, togeth with comprehensive data on pulse sizes, etc., functions of various variables. J. D. CRAG

537.5

6883. The construction of Maze type [Geige counters and their characteristics between 0° a 50°C. R. FAVRE AND C. HAENNY. *Helv. phy Acta*, **26,** *No.* 1, 53–64 (1953) *In French.*

Full and detailed instructions are given for t construction of external-cathode type Geiger counte Following this technique consistently reproducib results can be obtained, giving counters with platea of ~300 V and slopes of 1·6% to 3% depending c the external resistance. Though the filling is argo alcohol the counter characteristics are quite stab over a range of counting rates from 300–700 counts/min and temperature from 5° to 50°C. A explanation of this is given. L. E. MUSSE

537.5

6884. Scintillation counters. J. B. BIRKS. *Londo Pergamon Press* (1953) 148 *pp.*

A comprehensive and critical account of th development, characteristics and applications of th scintillation counter is given. The first two chapte give the general principles and characteristics of th counter, such as phosphor emission, photocathod performance and multiplication. In chapters 3 and the various types of photomultiplier are described an problems such as light collection, pulse height resol tion, time resolution and spurious counting an discussed. The text includes comparisons of th performance, characteristics and applicability c commercial tubes now available. Chapter 5 deal with the characteristics of inorganic phosphors use in the counters, such as zinc sulphide, sodium iodid and other alkali halides, tungstates and miscellaneou other types. Chapter 6 describes organic crystallin phosphors with special attention to anthracene bu including many types of hydrocarbon crystals no

ıse. Consideration is given to deterioration pro-es in the phosphors due to particle bombardment. ıpter 7 deals with liquid and plastic scintillators. last chapter is concerned with applications of the ınter, in particular, to the detection and spectro-ry of heavy particles, including neutrons, and to detection and spectrometry of electrons, γ-rays X-rays. It concludes with applications to meson positron detection. An up-to-date bibliography ovided together with a comprehensive subject ex. G. F. J. GARLICK

537.542

5. Liquid scintillation counting of tritium-labeled er and organic compounds. F. N. HAYES AND G. GOULD. *Science*, **117**, 480–2 (*May* 1, 1953).

537.542

6. Response of a zinc sulphide screen to α rays energy less than 5 MeV. J. P. ANTHONY AND G. BROSINO. *C.R. Acad. Sci.* [*Paris*] **236**, 1774–6 (*ay* 4, 1953) *In French.*

537.542

7. The airborne radiation detector. *Atomics ndon*] **4**, 140–1 (*June*, 1953).

A brief review of constructional and operational ails of a scintillation counter (NaI) plus associated ipment suitable for aerial survey work.

J. J. WILKINS

537.542

8. A convenient assembly for Čerenkov counters ng head-on type photomultiplier tubes. R. H. LDEBRAND. Note in *Rev. Sci. Instrum.*, **24**, 463–4 *ne*, 1953).

537.542

9. Scintillation counters using liquid luminescent dia for absolute standardization and radioactive say. E. H. BELCHER. *J. sci. Instrum.*, **30**, 286–9 *ug.*, 1953).

A scintillation counter designed for the standard-ation of radioactive isotopes by 4π–β-counting, d for the radioactive assay of small biological mples by γ-counting is described. The instru-ent uses a liquid luminophor in conjunction with uncooled end-window photomultiplier tube. tails are given of performance with various com-only used radioactive isotopes. A.

537.542 : 535.371

10. The absolute scintillation efficiency of anthra-ne. J. B. BIRKS AND M. E. SZENDREI. Letter in *ys. Rev.*, **91**, 197 (*July* 1, 1953).

An attempt is made to determine by photometric libration the absolute scintillation efficiency of thracene for alpha particles. Values of 0·042% d 0·223% are obtained for particles of 1·18 and 85 MeV respectively. G. F. J. GARLICK

537.542 : 550.839

11. Scintillation unit for drill-hole logging. . J. DIGIOVANNI, R. T. GRAVESON AND A. H. YOLI. *ucleonics*, **11**, 34–9 (*April*, 1953).

Details of a scintillation type drill-hole probe and associated circuits and equipment are given. A rge NaI(Tl) crystal is used as a detector. A much gher logging rate is possible with a scintillation detector than with a G–M counter. Gamma energy spectrum measurements are possible and ores may be identified by this means. L. R. SHEPHERD

537.542 : 537.591.08

A counting rate meter for recording of the cosmic-ray intensity, and some general remarks on the statistics of the ratemeter. *See Abstr.* 6913

537.542 : 621.318.572

6892. The reproduction of voltage impulses with a proportional amplifier. U. CAPPELLER. *Z. angew Phys.*, **4**, *No.* 9, 330–43 (1952) *In German.*

A detailed theoretical treatment of amplifier response, for counting systems involving Geiger or crystal counters. The effects of various circuit parameters are discussed, including those of feedback arrangements. J. D. CRAGGS

537.542 : 621.318.572

6893. An experimental study of counting losses due to dead-time effects. C. H. WESTCOTT, J. S. GREENBERG AND J. S. KIRKALDY. *Canad. J. Phys.*, **31**, 859–97 (*July*, 1953).

When using counting methods for studying instantaneous reactions produced with pulsed accelerators such as synchrotrons or synchrocyclotrons, the systematic errors in counting due to dead-time effects may be considerable. One of the authors has already published a discussion of the simpler cases of pulsed single-channel counting [Abstr. 3873 (1948)]; the present paper describes experimental investigations designed to extend knowledge of these corrections, especially to cases of coincidence counting. In Pt I of the present paper, the method and apparatus are described, together with calibration procedure; in the course of checking results already known from computation, defects in the functioning of the equipment were uncovered and the correction of these defects is described. Pt II deals with the problems of coincidence counting at high speed but without the complication of a pulsed source. Difficulties arise in this case unless the rate of occurrence of coincidences is much smaller than the counting rates in the separate counters, a condition which may not be satisfied in many cases in the study of high energy reactions. The corrections for this case have therefore been investigated experimentally and a relatively simple correction formula obtained when chance coincidences are negligible. The dependence of the number of additional chance coincidences on coincidence gate-width is determined both theoretically and experimentally, with satisfactory agreement. In Pt III the investigation is extended to pulsed coincidence counting. A theoretical formula is developed neglecting chance coincidences, for pulse-lengths less than twice the dead-time, and experiments confirm the results and indicate how to extrapolate for longer pulse-durations. A first-order formula for the chance coincidences is also obtained and confirmed. In all cases near-rectangular pulse-forms are used, but the equipment can readily be modified to study other forms. For the guidance of the user, the principal formulae adopted for determining counting corrections are collected in an appendix at the end of the paper. A.

537.542 : 621.318.572

6894. An improved fast scaler. H. K. SCHOENWETTER. *Rev. sci. Instrum.*, **24**, 515–17 (*July*, 1953).

A fast scale of four has been developed in which the emphasis has been on reliability. Since the scale of two units employ diode clamping to limit the plate and grid voltage excursions, the most important requirements are (1) proper choice of grid clamping voltages, (2) the grid swing without grid clamping should be considerably larger than and symmetrical about that obtained with grid clamping. To satisfy these and other requirements, metallic film precision resistors are used extensively, and the critical bias voltages are controlled by compensating networks. The resolving time for 3 or more evenly spaced trigger pulses is about 0·06 microsecond. Pulse heights ranging from 6 to 16 volts may be used. A.

537.542 : 621.385.12 : 621.318.572

6895. A scaling unit employing multi-electrode cold-cathode tubes. K. KANDIAH. *Inst. Elect. Engrs, Paper* 1529, 12 *pp.* (1953) [To be published also in *Proc. Inst. Elect. Engrs*].

A complete scaling unit for counting regular or random pulses is described. The unit employs cold-cathode scaling tubes and trigger tubes in the main counting circuits. Various methods of driving cold-cathode scaling tubes are fully described. A novel method of driving the CV2271 scaling tubes is used in which the amplitudes and durations of the pulses to all stages in a cascade of these tubes are controlled directly by a common pulse generator, and cold-cathode trigger tubes are used as gating elements between the stages. A new type of pulse-amplitude discriminator of high sensitivity is used at the input of the scaling unit. A simple system of marginal testing of the complete equipment is incorporated in order to obtain early indication of deterioration of tube characteristics. A.

537.542 : 539.163.08 : 621.318.572

Ten-channel pulse interval analyser. *See Abstr.* 7063

537.542 : 535.89

Flash tube for illuminating Wilson chamber. *See Abstr.* 6690

537.542 : 778.4 : 778.34

Stereoscopic cameras for use with a Wilson cloud chamber. *See Abstr.* 7371

IONIZATION . THERMIONICS 537.56/.58

537.56

6896. On the ionization loss of a fast particle in a dielectric medium. G. N. FOWLER AND G. M. D. B. JONES. *Proc. Phys. Soc.* [*London*] *A*, **66**, 597–600 (*July*, 1953).

A difficulty which has arisen in the physical interpretation of the theory of the ionization loss by fast particles on passing through matter is discussed and it is shown how it is resolved by using a more general expression for the dielectric constant. A.

537

6897. Simultaneous measurement of ionization attachment coefficients. M. A. HARRISON AND GEBALLE. *Phys. Rev.*, **91**, 1–7 (*July* 1, 1953).

Measurements have been made of pre-breakd currents in four gases: oxygen, air, freon-12 (CCl_2 and CF_3SF_5. The behaviour of these currents dif from that previously attributed to all gases in t semilogarithmic graphs of current against electr separation at constant E/p exhibit initial curvat being concave toward the electrode separation a At low E/p an apparent saturation is found. T behaviour is interpreted as resulting from a react of dissociative attachment of the kind $AB + e$ $(AB^-)^* = A + B^-$. On this basis simultaneou determined values of the ionization and attachm coefficients can be deduced. In oxygen and air th parameters, when determined from separate exp ments, show a somewhat anomalous behavio The apparent anomalies are explained with the re that ionization is found to commence at lower, a attachment persist to higher values of E/p t previously suspected. In freon-12 and CF_3SF_5 it found that the ionization coefficient is about an or of magnitude larger than reported for similar ga when no account is taken of possible attachme The attachment coefficient is observed to be lar for halogen-containing molecules than for the sa halogens when free. Cross-sections for attachme are computed for oxygen and air. Dependence of t cross-sections on mean electron energy is discuss with reference to energy scales in these two gases.

537.56 : 539.

6898. Measurement of ionizability of particles the new magnetic spectrometer. V. KHARITONC *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 71–4 (1952) *Russian.*

An extended series of tests with two proportion counters has been carried out over several months test the reliability of the arrangement for measurin ionizing capacities with the magnetic spectromet previously described [Abstr. 2803, 2792 (1952 The ionizing capacities of mesons and proto entering the apparatus agree with calculated valu except for protons of range $< 3 \cdot 5$ cm, and this explained by limitations of the recording equipmen R. C. MURRA

537.561 : 533

6899. Van der Waals' a and ionization potential inert gases. Y. P. VARSHNI. Letter in *J. chem. Phys* **21**, 1119 (*June*, 1953).

It is found empirically that these quantities satis a relation of the form $a = A + B/V^4$. R. O. DAVI

537.564 : 539.16

6900. The electric collection of radioactive ions bromine, technetium and indium. P. T. BARRET *Proc. Roy. Soc. A*, **217**, 104–10 (*June* 9, 1953).

Experiments have been made on neutron-irradiate ethyl bromide in order to investigate the rate of accu mulation of ions of Br^{80} and Br^{80*} due to an electri field between aluminium window electrodes. Th majority of the radioactive ions carried a negativ

rge; when these had been swept away, positive s of Br^{80} produced by the isomeric transition from ^{0*} were quite stable. In addition, an electric field a few hundred V/cm completely inhibited the ombination of these positive ions to form the ent molecule. Using an ether solution of molyb- num chloride, the 6 hr metastable state of Tc^{99*} s concentrated on a negatively charged nickel ctrode from its equilibrium state with the 67 hr ent Mo^{99}, a β-emitting isotope. The electrical raction, as a positive ion, of the 105 min isomer ^{13*} produced by K-capture decay from Sn^{113} was ieved in an atmosphere of $SnCl_4$ vapour at a ssure of 12 mm Hg. The significance of these ults in forming a picture of the chemical reactions luced by nuclear events is discussed; in particular, appears that in all the cases studied, the initial oduct of the nuclear event is a positively charged lioactive ion. A.

537.564 : 551.510.535

01. Experimental studies of the motions of slow ctrons in air with application to the ionosphere. W. CROMPTON, L. G. H. HUXLEY AND D. J. TTON. *Proc. Roy. Soc. A*, **218**, 507–19 (*July* 23, 53).

From careful experiments on the motions of slow ctrons in air, it has been possible to deduce pirical formulae from which may be derived the ift velocity, collisional frequency, electronic tem- rature and mean energy loss per collision. These sults applied to the ionosphere allow electronic llisional frequencies to be readily found in the nosphere below 94 km, from the pressure of the alone. It is considered that the values of the llisional frequencies found in this manner are more stworthy than any that have been suggested hitherto. he accuracy is limited by the accuracy of the data pressure found by other means. The collisional oss-sections of the molecules of air and nitrogen hen the electronic temperature is less than about 00°K has been found to be directly proportional to e speed of the electron. A.

537.565 : 537.542

02. Grid ionization chamber measurements of ectron drift velocities in gas mixtures. W. N. NGLISH AND G. C. HANNA. *Canad. J. Phys.*, **31**, 8–97 (*July*, 1953).

Electron drift velocities have been measured in the w X/p region from 0·05 to 0·5 volts per cm per mm ercury which is an important one for the calculation collection times in electron pulse chambers. The id ionization chamber method is rapid and con- enient and gives an accuracy of about 10%. Mixtures the noble gases neon, argon, krypton and xenon ith carbon dioxide and/or methane have been udied, as well as a number of unpurified "tank" ases. In the mixtures used there are anomalies, or umps, in the drift velocity curves which seem to be rrelated with the "Ramsauer" electron free paths the four noble gases. There is a striking difference the effect of carbon dioxide and of methane when dded in small amounts to the noble gases, which attributed mainly to the difference in electron mean ee path in these two gases, but may also be an indication of a difference in electron energy distributions. A.

537.568 : 551.510.535

6903. Determination of the coefficient of recombination in the ionosphere. Y. V. SOMAYAJULU. Letter in *Sci. and Culture*, **18**, 494–6 (*April*, 1953).

Values of the recombination coefficient at night are deduced from fixed frequency pulse observations of the time interval between the disappearance of the ordinary and extraordinary ray components. It is shown that either vertical or oblique incidence observations can be used for this purpose.

W. J. G. BEYNON

537.571

6904. Ionization in liquids due to alpha particles. E. W. T. RICHARDS. *Proc. Phys. Soc.* [*London*] *A*, **66**, 631–7 (*July*, 1953).

The ionization current produced by polonium α-particles in liquid hexane has been studied using a collimated beam so that it has been possible to determine the direction of the α-particles with respect to the collecting electrostatic field. Measurements of the ionization current have been made with various collecting field strengths and experiments conducted in which the attempts were made to measure the specific ionization. The ion currents measured were of the same order of magnitude as those obtained by earlier experimenters but no dependence on the angle between the direction of the α-particles and the field was observed. This was in contradiction to results as calculated using Jaffé's columnar theory. The experimental values of the specific ionization do not conform to the Bragg curve as in the case of gases, but all the experimental results obtained are consistent with a calculation assuming that the only ions which can be collected are formed by δ-rays at some distance from the α-particle track. A.

537.581

6905. Thermionic constants of metals and semiconductors. III. Monovalent metals. S. C. JAIN AND K. S. KRISHNAN. *Proc. Roy. Soc. A*, **217**, 451–61 (*May* 21, 1953).

For Pt II, see Abstr. 2516 (1953). In this part are described measurements on the thermionic constants of the monovalent metals copper, silver and gold, made by the effusion method. Owing to the low melting-point of these metals, and the consequent low vapour pressure of the electron gas in thermal equilibrium with them, the effusion holes used had to be much larger than in the measurements with the other metals. The maximum size of the effusion hole that can be used with an electron gas chamber of given dimensions without disturbing appreciably the equilibrium condition in the chamber, and the effect of the large size of the effusion hole on the saturation current, are discussed in some detail. For all the three metals, the A coefficient in Richardson's equation for thermionic emission is found to be only slightly short of the theoretical value of 120 amp cm^{-2} $deg.^{-2}$ This experimental finding is of significance, since the lowering of the thermodynamic potential of the degenerate electron assemblage in these metals, consequent on the thermal expansion of the metal, is considerable. A.

537.583 : 537.311.31 : 621.3.011.22

6906. Electrical resistivity and thermionic emission of silicon. L. ESAKI. *J. Phys. Soc. Japan*, **8**, 347–9 (*May–June*, 1953).

Simultaneous measurements of electrical resistivity and thermionic emission of silicon over the intrinsic temperature range from 1100°C to 1350°C have been carried out by heating a small silicon piece directly. The results indicate that the depth of the conduction band, the energy gap between filled and conduction bands and the work function are 3·47 eV, 1·10 eV and 4·02 eV, respectively, and also Richardson's constant 5·6 amp. cm^{-2} deg^{-2}. A.

537.583 : 537.311.31 : 621.385.032.216

6907. Relationship between thermionic emission and electrical conductivity of oxide-coated cathodes. S.-I. NARITA. *J. Phys. Soc. Japan*, **8**, 331–8 (*May–June*, 1953).

The relationship has been investigated for both "sintered" and normal oxide-coated cathodes. The "χ" values obtained from the difference between the work functions and the activation energies of conductivity were very inconsistent between both cathodes. Moreover, in the low temperature range an activation energy of conductivity smaller than 0·1 eV was observed. These results are attributed to the existence of numerous conduction mechanisms in the oxide coating and to the surface formation of a barium layer on the oxide particles. A.

537.583 : 621.317.31 : 621.385.2.032.216

6908. Temperature dependence of low frequency fluctuations in thermionic emitters. T. B. TOMLINSON. *J. appl. Phys.*, **24**, 611–15 (*May*, 1953).

A method is described for measuring the temperature variation of the low frequency fluctuations of emission current (flicker effect) in diodes with oxide-coated cathodes. In order to vary the cathode temperature and at the same time avoid the effects of space charge and the variation due to changes of the mean current, it is necessary to operate the test diodes under retarding field conditions. The results show that the majority of tubes exhibit minimum fluctuations at a cathode temperature in the region of 1000°K, although both rising and falling temperature characteristics are encountered. It is concluded that the flicker effect is in fact a combination of at least two separate phenomena. Finally, the various theories are examined in the light of the new information, and none is found to be completely satisfactory. A.

537.583 : 621.385.032.21

6909. Metal capillary cathodes. H. KATZ. *J. appl. Phys.*, **24**, 597–603 (*May*, 1953).

Describes work on the development of new types of cathodes, using elements such as barium or thorium as emitters. If provided with a suitable base, these elements are able to migrate and, acting as an atomic layer, reduce the work function of the base material. By introducing a separate supply source below the emitting surface, a work-function-reducing substance will be caused to migrate to the cathode surface through small capillaries. Evidently a wide range of new types of cathodes is feasible, since the independently stored emitter of a metal capillary cathode can be held at a temperature different from that of the cathode surface. A.

537.583 : 621.385.032.

6910. Double activators in oxide cathode base all A. EISENSTEIN, H. JOHN AND J. H. AFFLECK. *J. ap Phys.*, **24**, 631–2 (*May*, 1953).

The presence of tungsten as a major impurity in base metal of an oxide-coated cathode leads to formation of the interface Ba_3WO_6. If silicon is a present, but as a minor impurity, this element gradua replaces tungsten in the interface to form Ba_2Si Similar reactions between titanium and aluminiu with other known interface compounds w examined.

537.5

6911. On the study with a mass spectrometer of t ionic emission of alumino silicates. J. BEAUSSIER AN G. COUCHET. *C.R. Acad. Sci.* [*Paris*] **236**, 1417– (*April* 8, 1953) *In French.*

Alkali alumino silicates were used as sources, a the alkali ion currents, due to the main and t impurity alkalis, were studied as a function of tim source temperature and residual air pressure. Th results show the ionic emission to be considerab modified by surface phenomena and the presence small quantities of impurities. J. HUGH

COSMIC RAYS 537.591

537.59

6912. Ionization of cosmic ray mesons in argo J. K. PARRY H. D. RATHGEBER AND J. L. ROUS *Proc. Phys. Soc.* [*London*] *A*, **66**, 541–8 (*June*, 1953)

The ionization of cosmic-ray mesons with momen tum in the range 3×10^8 to 7×10^{10} eV/c was invest gated using an argon-filled proportional counter. Th results obtained are in agreement with theoretica calculations and show evidence of a polarizatio effect. A

537.591 : 523.

Meteorites and cosmic rays. *See Abstr.* 6397

537.591.08 : 537.54

6913. A counting rate meter for recording of th cosmic-ray intensity, and some general remarks on th statistics of the ratemeter. H. TREFALL. *Univ Bergen Arbok*, *Paper* 3, 16 *pp.* (1952).

A counting-rate meter has been built for recordin cosmic-ray intensity, taking due regard of the low intensity, small variations and long recording time necessary to obtain statistically significant results The construction and operation of the rate-meter are described; the greatest difficulty was to obtain adequate stability. The mathematical connection between the recorded output and the counting rate is derived, and the statistical properties are studied. The cumulative function of the output is found and is used in the study of the distribution function. A.

537.591.1

6914. Size distribution of cosmic ray stars in photo graphic emulsions. J. Y. MEI. *Canad. J. Phys.*, **30**, 453–8 (*Sept.*, 1952).

In an analysis of cosmic-ray stars found in Ilford G5 emulsions exposed at about 85 000 ft, the star-size distribution curve shows a change in slope at a prong number of about 8·5. A similar effect is shown

emulsions exposed at airplane altitudes, and it assumed that the effect is mainly due to the composition of the emulsions. While the primary particles producing the stars at about 85 000 ft are mostly protons, about 50% of the low energy stars are produced by non-ionizing radiation, presumably neutrons. Alpha-particles and heavier nuclei produce about 30% of the larger energetic stars. The absolute frequency of star production is given. A.

537.591.1 : 523.161

Kinematic properties of interstellar gas in connection with the isotropic cosmic rays. *See Abstr.* 6386

537.591.15

15. Auger showers and the density of the upper atmosphere. A. DAUDIN AND J. DAUDIN. *C.R. Acad. Sci. [Paris]* **236**, 1352–4 (*March* 30, 1953) *In French.*

Air showers extending over a distance of 5 m with mean density of ~10 particles/m² have been investigated at Pic du Midi and it is shown that the frequency of these showers is a function of both atmospheric pressure and temperature. Correlations have been carried out using the heights of various atmospheric pressure levels and it is shown that the correlation is highest for the 200 mb layer. H. ELLIOT

537.591.15

16. The time distribution of delayed particles in extensive air showers using a liquid scintillation counter of large area. J. V. JELLEY AND W. J. WHITEHOUSE. *Proc. Phys. Soc. [London] A*, **66**, 454–66 (*May*, 1953).

A liquid scintillation counter, of area 1000 cm² and depth 15 cm has been developed for experiments on the delayed particles in extensive air showers. The scintillator was used in conjunction with two trays of Geiger counters to select showers of average density 5/m²; the prompt and delayed particles traversing the scintillator were recorded photographically in an arrangement in which possible sources of spurious delays were eliminated. The existence of delayed particles was confirmed and the delay distribution obtained over the range $(3–70)\times10^{-8}$ sec. This distribution could be represented by an exponential function with half of the delayed particles arriving within $(10 \pm 2)\times10^{-8}$ sec. The total fraction of shower particles that suffer delays in the above range was found to be $(0{\cdot}85 \pm 0{\cdot}05)\%$. There is evidence that showers with delayed events do not differ in average density from those without such events. A control experiment was carried out to investigate any spurious effects; this revealed μ–e decay events in the scintillator at approximately the expected rate. A.

537.591.15

917. The lateral structure of cosmic ray extensive air showers at sea level. S. R. HADDARA AND D. AKEMAN. *Proc. Phys. Soc. [London] A*, **66**, 549–58 (*June*, 1953).

The axes or cores of extensive air showers were selected by observing in a cloud chamber cascade showers produced by a single high-energy ($>5\times10^9$ eV) electron or photon, and an upper limit of 5 m for the spread of such particles has been found. By placing trays of hodoscoped counters at various distances from this core selector it was possible to determine the relation between density of ionizing particles and distance from the axis for showers of approximately 10^4–10^5 particles. The experimental arrangement and method of analysis used have certain advantages over those employed by other workers. It is concluded that although the results of the present experiment and those of other workers are consistent with the Molière structure function, not too much weight should be placed on this agreement. A.

537.591.15

6918. A cloud-chamber study of cosmic ray showers under lead in the neighbourhood of the second maximum of the absorption curve. G. PFOTZER. *Z. Naturforsch.*, **8a**, 353–60 (*June*, 1953) *In German.*

Examination of the cloud chamber photographs show that there are no appreciable quantities of unusual types of showers in the region of the second Rossi maximum. Other hypotheses for the mechanism of production of this maximum are discussed. J. HUGHES

537.591.3

6919. The energy spectrum of the soft component of cosmic radiation. J. CLAY. *Physica*, **19**, 51–60 (*Jan.–Feb.*, 1953).

The absorption of the soft (electron) component of cosmic radiation was measured in Pb, Fe and Al with the aid of Scheen's range-energy relation for these materials. For the differential energy spectrum of the form $N = N_0E^{-S}dE$, S was calculated for $E < 10^8$ eV and found to be 1·58 for Al, 1·56 for Fe and 1·50 for Pb. The value for Pb is in perfect agreement with earlier measurements by another method. The absorption spectrum of particles produced in Pb, Fe, Al and paraffin was also investigated, and the energy in these cases calculated. Here the presence was noted of electrons with higher energies than those of the soft radiation in the atmosphere. On account of the small absorption of the producing particles in the producing layers, the most acceptable conjecture seems to be that this production is caused by high energy photons. A.

537.591.3

6920. Investigation on the low energy end of the cosmic proton and meson spectrum at sea-level by applying a differential absorption method. P. J. G. DE VOS AND E. VAN A. GEY VAN PITTIUS. *Physica*, **19**, 305–10 (*April*, 1953).

The experimental arrangement is similar to one designed by Rogozinski and Lesage [see Abstr. 5515 (1949)] with certain variations introduced. The method consists in counting the number of particles emerging from a well-defined thickness of lead and stopping in an additional differential absorber. Coincidences are triggered only by rays incident within the solid angle defined by a vertical counter telescope. The present spectrum exhibits a remarkable resemblance to the curve obtained by the writers quoted above. An interpretation of this curve is given. A.

537.591.3

6921. The low energy spectrum of cosmic-ray mesons at sea level at high geomagnetic latitudes. D. C. ROSE AND A. G. VOISIN. *Canad. J. Phys.*, **30**, 373–87 (*Sept.*, 1952).

The differential range spectrum of cosmic-ray

mesons has been measured by three different methods the first of which was used at two northern geomagnetic latitudes 56·8 (Ottawa) and 83·0 (Resolute in the Canadian Arctic). In the first method the integral spectrum was measured by absorption, and after various corrections the differential spectrum was derived. In the second method the number of particles stopped in a block of lead was measured by a coincidence–anticoincidence arrangement of counters. In the third method the delayed coincidence method was used, the meson being identified by its decay electron. Over the range studied (ranges in lead up to 700 g/cm²) the results of the three methods are in general agreement and agree with others in that the smoothed data show only a small variation in intensity over the range studied. Some of the results suggest that a more detailed study of the spectrum might show some irregularities in the intensity variation with range. As would be expected no significant difference was found in the shape of the curves at the two stations. A.

537.591.3

6922. Slow π-mesons in cosmic-ray stars and the negative–positive π-meson ratio. J. Y. Mei and E. Pickup. *Canad. J. Phys.*, **30**, 430–7 (*Sept.*, 1952).

In a survey of mesons ending in the emulsion no τ- or κ-mesons have been observed so far. The variation of the negative–positive π-meson ratio with energy shows up the effect of the Coulomb barrier on π-meson production at very low energies. The variations of this ratio at mountain and balloon altitudes are discussed. Examples have been obtained of the emission of slow π-mesons in hydrogen collisions in the emulsion, and also in energetic stars with several shower particles and few evaporation particles. A.

537.591.3

6923. Properties of the low energy nucleonic component at large atmospheric depths. J. A. Simpson and W. C. Fagot. *Phys. Rev.*, **90**, 1068–72 (*June* 15, 1953).

This is a report on the absorption properties of the cosmic radiation low-energy nucleonic component measured by detectors of disintegration product neutrons as the nucleonic cascade develops deep within the atmosphere. The air absorption mean free path L of the star- or neutron-producing radiation was measured as a function of atmospheric depth x (in g-cm^{-2} atmosphere) at the geomagnetic latitudes $\lambda = 0°, 41°, 52°$. $L(x, \lambda)$ was obtained for carbon or free atmosphere and for a lead plus carbon pile geometry. As reported earlier [Abstr. 4191 (1953)], for small x the absorption mfp, L, is dependent upon λ (L is a function of the average energy of the primary nucleons which initiate the nucleonic chain or cascade). However, it is shown by the present measurements that, for $x > 600$ g-cm^{-2}, $L \to \sim 140$ g-cm^{-2} independent of latitude λ. The latitude dependence of neutron component intensity was measured at $x = 680$ g-cm^{-2} (11 200 ft) between $\lambda = 0°$ and 58°N. The latitude factor of intensity increase is 2·55. In view of the independence of $L(x)$ on λ at large atmospheric depths this latitude effect is nearly constant down to sea level ($x = 1030$). It is shown that at large atmospheric depths neutron production is observed from primary protons wi energies as low as ~1 BeV. The specific yield neutrons at 11 200 ft has been computed taki into account protons, alpha-particles, and heavi primary nuclei. These measurements resolve d crepancies reported in the literature between hi altitude measurements and measurements between s level and mountain altitudes for the low-ener nucleonic component.

537.591

6924. Meson asymmetry at the geomagnetic equato I. V. Escobar and F. B. Harris, Jr. *Nimbus*, 31–63 (*Jan.–June*, 1952); in more complete form *Cuaderno No.* 1, *Laboratorio de Fisica Cosmica Chacaltayo, Universidad Mayor de San Andrés, La Pa Bolivia.* 70 *pp.* (*June*, 1952) *In Spanish.*

An apparatus is described which is essentially selector of μ-mesons in a field of 18 000 gauss di criminating between particles of energy 1·3–2·6 Be and particles of energy 0·8–1·3 BeV. A review theories on the effect of the earth's field on the cosm radiation is given, and preliminary results reporte obtained at 49°N magnetic latitude and 3240 altitude, where the east–west asymmetry was 11–12 both for + and − μ-mesons and for both interva of energy. L. Pincherl

537.591.

6925. Cosmic radiation intensity-time variations an their origin. II. Energy dependence of 27-day varia tions. W. H. Fonger. *Phys. Rev.*, **91**, 851–61 (*July* 1 1953).

For Pt I, see Abstr. 6126 (1953). Cosmic-ra intensity-time variations recorded in the lower atmo sphere by one neutron detector (D-1, Climax Colorado) and three ionization detectors (Freiburg Germany; Cheltenham, Maryland; and Huancayo Peru) are compared. Irregular intensity variation characterized by time parameters of 27 days an 24 hours are shown to occur in coincidence in the records of both types of detectors. It seems reason able to ascribe correlated neutron and ionizatio intensity variations to a common origin. It has bee shown that 27-day neutron intensity variations ar produced by primary intensity variations. The mag nitude of these variations must be greater for lo energy primaries as 27-day neutron intensity varia tions at Climax are ≃ 5 times larger than correspond ing ionization intensity variations at Freiburg, Chel tenham, and Huancayo. These variations must extend, however, to high energy primaries, as their effects are observed at the geomagnetic equator From the ≃ 5 : 1 relative response (Climax neutron to northern sea level ionization detector) one parameter describing the energy dependence of 27-day primary intensity variations can be empirically evaluated. Assuming a power law similar to that describing the energy dependence of the time average primary intensity spectrum, it is found that the amplitude of 27-day primary intensity variations is required to decrease with increasing primary energy approximately one power of energy more rapidly than the time average primary spectrum itself. The electric field acceleration process hypothesis predicts primary intensity variations with approximately this energy dependence. Twenty-four-hour neutron (Climax) and

vation (Freiburg) intensity variations are cor-ed in local time. It is not certain that these ations are produced by primary intensity varia-s. Even if this were the case, the relative response max to Freiburg) to such primary intensity varia-s cannot be accurately determined from the data ied here. A.

537.591.8

6. Cloud chamber observations of the cosmic ation underground. E. P. GEORGE, J. L. REDDING P. T. TRENT. *Proc. Phys. Soc.* [*London*] *A*, **66**, -40 (*June*, 1953).

a study of the passage of fast charged particles ugh a cloud chamber containing two Pb plates at epth below ground equivalent to 60 m water, mples of associated pairs of penetrating particles of large angle scattering of single particles were erved. If these events are interpreted as the duction of secondary particles by μ-mesons, and anomalous scattering of μ-mesons in Pb, the owing cross-sections per nucleon result: for etrating secondary particles 4×10^{-29} cm^2, and for malous large angle scatter 2×10^{-28} cm^2. A.

537.591.8

7. A cloud-chamber study of neutron production sea-level cosmic rays, with particular reference to esons stopped in lead. E. J. ALTHAUS AND R. D. D. *Phys. Rev.*, **91**, 373–84 (*July* 15, 1953).

A multiple-plate cloud chamber has been used at level to test the conclusion drawn from counter eriments that neutrons of several MeV energy are erated when negative μ-mesons are stopped in lead. e stopped mesons are recognized by comparison of ually estimated ionization and range. With the te thicknesses used, mesons can be distinguished m electrons and protons. To discriminate against esons, which would have to be produced locally, re is a minimum of condensed material above the mber, and mesons accompanied by any other ticle in the top compartment are excluded from the tistics. Alternate plates of Pb and C of equal pping power are used, evaporation neutrons being ected from mesons stopped in the Pb but not from sons stopped in the C. The chamber is surrounded paraffin and BF_3 counters, for the detection of trons originating in the plates; a G.M. tube escope above the chamber selects charged particles ected through the chamber. The chamber is anded when a telescope coincidence is associated h at least one detected neutron. In 1207 accepted tures there are 14 definite cases of mesons stopping the Pb, none of mesons stopping in the C. In-ding probable as well as definite identifications, the responding numbers are 19 and 1. These results nfirm the production of evaporation neutrons in meson capture in Pb. The large Pb : C ratio ows that π-meson contamination is negligible when authors' selection criteria are used. The neutron incidence pictures reveal the various processes ing rise to these events. Electronic showers count for a large fraction; the "giant resonance" of MeV photons in Pb is probably responsible. bout 20% of the events are energetic nuclear inter-tions. There is a significant yield of single pene-ting particles, some of which must be fast μ-mesons interacting in Pb with small energy loss. The rate is consistent with underground measurements of the neutron yield. A V^0 decay has been found with both branches heavily ionizing; it appears to be a V_1^0 with Q in the range 30–55 MeV. A.

537.591.8

6928. The production of mesons above 10 BeV. C. B. A. MCCUSKER, N. A. PORTER AND B. G. WILSON. *Phys. Rev.*, **91**, 384–7 (*July* 15, 1953).

12 000 local penetrating showers from carbon and paraffin have been compared using a 31-channel hodoscope in order to study nucleon-hydrogen collisions above 10 BeV. The average multiplicity of penetrating charged particles from the detected showers from carbon is found to be $4\cdot42 \pm 0\cdot20$ and the multiplicity from hydrogen considerably less. An upper limit of 2·4 is given. It is concluded that the multiple production of mesons is infrequent at this energy. A.

MAGNETISM 538

538.11

6929. The application of Kirkwood's approximation to the calculation of intrinsic magnetization. R. H. TREDGOLD. *Proc. Phys. Soc.* [*London*] *A*, **66**, 421–7 (*May*, 1953).

The limitations of Opechowski's method of calculating the variation of intrinsic magnetization with temperature are pointed out. An alternative method, based on Kirkwood's treatment of crystallographic ordering, is proposed. It is shown that this method is equivalent to Heisenberg's treatment in the first and second approximations. The third approximation leads to two Curie temperatures which are separated by a smaller interval than in the case of the Heisenberg second approximation. This result is discussed in the light of previous work and the suggestion is put forward that a model in which the exchange interaction is limited to nearest neighbours is incapable of explaining the behaviour of the known ferromagnetic materials. A.

538.113

6930. The diamagnetism of quasi-bound conduction electrons. A. H. WILSON. *Proc. Camb. Phil. Soc.*, **49**, *Pt* 2, 292–8 (1953).

Re-investigates the theoretical problem previously discussed in the author's *Theory of Metals* (1936). The density matrix is calculated to order H^2, where H is the field strength. The method may be used, in principle, to obtain the complete solution (steady diamagnetism) to this order, but the result is so complicated that only the dominant terms are given, viz. those involving second-order derivatives of the energy with respect to the wave vector components.

E. P. WOHLFARTH

538.113

6931. The effects of interactions in a paramagnetic on the entropy and susceptibility. J. M. DANIELS. *Proc. Phys. Soc.* [*London*] *A*, **66**, 673–88 (*Aug.*, 1953).

Van Vleck's theory of magnetic dipole interaction is extended to take into account magnetic anisotropy of the individual ions, and hyperfine splitting. The

entropy and susceptibility are expressed as power series in $1/T$ as far as the term in $1/T^4$. Explicit formulae are found for the term in $1/T^2$ in the entropy, the important term at high temperatures, and for the Curie–Weiss Δ's; for paramagnetics with one ion in the unit cell and axial symmetry, and for the Tutton salts. This is done both in the case of a general interaction and also for pure magnetic dipole–dipole interaction. It is shown that the contributions of interactions and of hyperfine splitting to both the entropy and the susceptibility are additive as far as the term in $1/T^2$, and that hyperfine splitting introduces into the susceptibility shape-dependent terms which cannot be included in the Curie–Weiss Δ. This is followed by a review of the properties of cerium magnesium nitrate, the rare earth ethylsulphates, and the Tutton salts in relation to this theory. A.

538.114

6932. Antiferromagnetism. H. LABHART. *Z. angew. Math. Phys.*. **4**, *No.* 1, 1–24 (1953) *In German.*

A review dealing with: direct and indirect exchange forces, molecular field theory, more rigorous theoretical treatments, neutron diffraction studies, hysteretic properties, temperature variation of susceptibility, antiferromagnetic resonance, transition region properties. A list of the known antiferromagnetic substances and their principal properties is given, and there are 88 references covering the literature.

E. P. WOHLFARTH

538.114

6933. On the theory of the Ising model of ferromagnetism. G. F. NEWELL AND E. W. MONTROLL. *Rev. mod. Phys.*, **25**, 353–89 (*April*, 1953).

A mathematical review. The partition function is expressed in several alternative forms using the matrix formulation and the combinatorial formulation. The existence of phase transitions is discussed, consideration being given to the duality theorems (Onsager, Wannier) and to the existence of long-range order. The two-dimensional square lattice is considered using a combinatorial method (Kac and Ward) and an algebraic method (Onsager). Other lattice types are briefly discussed. The ferromagnetism of the two-dimensional Ising lattice is considered and the problem of spin correlations discussed. Three-dimensional lattices and the spherical model (Kac) are briefly considered. 47 references. E. P. WOHLFARTH

538.114

6934. Ferromagnetism in the iron group. F. BADER. Note in *Z. Naturforsch.*, **8a**, 334 (*May*, 1953) *In German.*

Gives qualitative theoretical arguments purporting to describe the curve giving the saturation magnetization per atom as a function of the number of *d* electrons for the ferromagnetic metals and alloys of the iron group. E. P. WOHLFARTH

538.122

6935. The magnetic fields produced by uniformly magnetized ellipsoids of revolution. H. J. PEAKE AND N. DAVY. *Brit. J. appl. Phys.*, **4**, 207–9 (*July*, 1953).

Expressions are obtained for the field produced by a uniformly magnetized ellipsoid of revolution with a given intensity of magnetization at external points on its axes of symmetry. The formulae are stated i form suitable for arithmetical calculation. Ta and graphs are provided.

538.122 : 621.3.

6936. Old and new definition of the idea of a magn field. M. LANDOLT. *Bull. Assoc. Suisse Elect.*, , 458–61 (*May* 16, 1953) *In French.*

A theoretical discussion based on Clerk Maxwe definition, and showing the effect of rationalizatio theory and numerical units. The new oersted introduced, based on the I.E.C. recommendatio 1935. Some examples are given. E. H. W. BANNER

538.

6937. Theory of anti-ferromagnetic resonance i crystal of rhombic symmetry at the absolute ze J. UBBINK. *Physica*, **19**, 9–25 (*Jan.–Feb.*, 1953).

The resonance condition in an anti-ferromagne rhombic crystal at zero temperature is derived on basis of static anti-ferromagnetism as analysed Gorter and Haantjes. The interaction of the io with their surroundings is assumed to consist only anisotropic exchange interaction with neighbouri magnetic ions. An anisotropic Landé factor of ions is introduced. At a given frequency the resonan condition is represented by a surface in field spa For zero frequency the surface is reduced to Gor and Haantjes' threshold hyperbola, at which the flo over of spins takes place, and to the boundary surfa between the regions where true anti-ferromagneti and saturated paramagnetism occur. The branch of the threshold hyperbola play an important rôle, low frequencies as the central lines of tunnel-like pa of the surface, at higher frequencies as lines singular points on the surface. At frequencies between, the surface is contracted and dissolved in four bulbs. At certain frequencies these bulbs a reduced to points on the axes of easiest and ne easiest magnetization. At high frequencies the surfa expands regularly for increasing frequency.

538.22

6938. Magnetic compounds with perovskite structur III. Ferromagnetic compounds of cobalt. G. H JONKER AND J. H. VAN SANTEN. *Physica*, **19**, 120– (*Jan.–Feb.*, 1953).

For Pt II, see Abstr. 5947 (1950). Polycrystalli mixed crystals (La, Sr) CoO_3 have been prepare Perovskite structure is found for all composition Ferromagnetism is observed for intermediate S concentrations. Curves are given for the saturatio magnetizations, the paramagnetic Curie temperature and the effective paramagnetic moments as a functio of composition. It is suggested that the ferro magnetism observed is caused essentially by a positiv $Co^{3+} - Co^{4+}$ interaction. The sign of the exchang interaction is discussed in connection with the theorie of Anderson, of Polder and of Zener.

538.22

6939. The temperature dependence of the spon taneous magnetization in an antiferromagnetic singl crystal. N. J. POULIS AND G. E. G. HARDEMAN *Physica*, **19**, 391–6 (*May*, 1953).

The time-average magnetic moment of the Cu ion in an antiferromagnetic single crystal of $CuCl_2 . 2H_2O$ was measured using the nuclear magnetic resonanc

ethod. This average moment is plotted as a function of the temperature. The curve obtained differs nsiderably from that calculated on the basis of the ory of Néel [Abstr. 3388 (1948)] and that of Van eck even if the square of the magnetic moment is otted against the temperature. It approaches the nperature axis vertically. Measurements were rried out in weak (1640 Oe) and strong magnetic lds (10 490 Oe). A.

538.221

40. Magnetic resonance in $LaMnO_3$ at low temrature. T. Okamura and Y. Kojima. *Physica*, , 412–14 (*May*, 1953).

Reports measurements between 78° and 143°K at crowave frequencies 23·5 and 9·45 kMc/s. The sonance formula is used in the form

$$\nu = (ge/4\pi mc)(H + H_i)$$

e internal field H_i varying between 360 and 80 rsted over the temperature range, the g value maining constant at 2·00. E. P. WOHLFARTH

538.221

41. Condition for vanishing spontaneous magtization below the Curie temperature. K. F. Niessen. *ysica*, **19**, 445–50 (*May*, 1953).

A method is derived for a special spinel structure owing vanishing spontaneous magnetization at a mperature below the Curie temperature T_c to termine this temperature (T_0). A condition is rived for the extreme case $T_3 \equiv T_c$ which can be plied to experiments for finding the ratio of mutual teractions of magnetic ions. A.

538.221 : 536.631

42. The specific heat discontinuity in antiferroagnets and ferrites. L. N. Howard and J. S. Smart. *ys. Rev.*, **91**, 17–19 (*July* 1, 1953).

It is shown that, in a molecular field approximation, e internal energy and specific heat of a ferromagnet d antiferromagnet have the same form, regardless of e number of sets of neighbours whose interactions e considered and of the signs of the interactions. he Néel theory is used to derive an expression for the scontinuity in specific heat in ferrites at the Curie mperature. This discontinuity ΔC is in general naller than it would be for a ferromagnet or antirromagnet with the same number of atoms. umerical calculations indicate that for most ferrites C should decrease monotonically as non-magnetic oms are substituted for magnetic atoms on the A tes. On the other hand, if the non-magnetic atoms on the B sites, ΔC should pass through a maximum. A.

538.222

43. Paramagnetic diffusion effect of sulphur ions silver bromide at high temperatures. N. Perakis. *R. Acad. Sci.* [*Paris*] **236**, 1474–6 (*April* 13, 1953) *French.*

In order to test the correctness of a latent image eory due to Mitchell (formation of S^- F-centres, equilibrium with Ag^{++} F-centres, both of which e paramagnetic) susceptibility measurements were rried out on AgBr and Ag_2S and also on a mixture f the two silver compounds. A paramagnetic phase, ue to the diffusion of sulphur ions, was observed the mixture above 220°c, the effect having a maximum at about 360°c. The results enable the extent of the diffusion process to be estimated.

E. P. WOHLFARTH

538.222

6944. On the paramagnetic electronic resonance in certain ions. J. Uebersfeld. *C.R. Acad. Sci.* [*Paris*] **236**, 1645–7 (*April* 27, 1953) *In French.*

The author describes apparatus for studying the phenomenon at 10 000 Mc/s; the substance is placed in a Pyrex tube along the axis of a cylindrical resonator (TE_{011} mode). Results are presented for various salts of copper, of manganese and of trivalent iron. The Landé factor is $\begin{matrix}<2\cdot27\\>1\cdot97\end{matrix}$ in every instance. T. J. REY

538.222

6945. Effect of mechanical treatment on the paramagnetic resonance of manganese in zinc sulphide powders. J. S. Van Wieringen. *Physica*, **19**, 397–400 (*May*, 1953) *In French.*

If wurtzite, the hexagonal modification of ZnS, is compressed at room temperature, it changes into sphalerite, the cubic modification. This has been observed by X-ray diffraction. The gradual transition manifests itself also in the paramagnetic resonance spectrum of small quantities of Mn dissolved in ZnS. This is because the paramagnetic resonance spectrum of divalent Mn is very sensitive to the presence or absence of non-cubic components of the surrounding crystalline field. The spectrum as a function of Mn concentration is shown. In non-compressed wurtzite powders the complete spectrum is resolved at higher concentrations (0·05%) than had been reported before (0·001%) for compressed powders. [See Abstr. 7091 (1951)]. A.

538.222

6946. Temperature variation of the paramagnetic resonance absorption of two free radicals. L. S. Singer and E. G. Spencer. Letter in *J. chem. Phys.*, **21**, 939–40 (*May*, 1953).

The paramagnetic resonance of such radicals is characterized by a narrow line width. It is assumed that this is caused by the strong exchange forces, which increase the fourth moment of the absorption line. In order to investigate this the resonance absorption of α, α diphenyl-β-picryl hydrazil (I) and of tris-p-nitrophenyl methyl (II) were measured. The apparatus used is described. Graphs are given showing variation of line width with temperature. The line shapes were numerically investigated in detail. For I the shape lay between a Lorentz and a Gaussian curve, for II the shape was closer to Lorentzian. The observed transition in line width for I between 20 and 50°K was not accompanied by a decrease in absorption. The increase in line width with decreasing temperature for both radicals suggests that a mechanism similar to the freezing out of molecular motions as in nuclear resonance may be involved. A. J. TAYLOR

538.222

6947. Second order nuclear quadrupole effects in single crystals. I. Theoretical. G. M. Volkoff. *Canad. J. Phys.*, **31**, 820–36 (*July*, 1953).

The dependence of electric quadrupole splitting of nuclear magnetic resonance absorption lines in single

crystals on crystal orientation in an external magnetic field is investigated theoretically following earlier work of Pound, of Volkoff, Petch and Smellie and of Bersohn. Explicit formulae are given, applicable to non-axially symmetric crystalline electric field gradients ($\eta \simeq 0$), and valid up to terms of the second order in the quadrupole coupling constant $C_z \equiv eQ\phi_{zz}/h$, for the dependence of the absorption frequencies on the angle of rotation of the crystal about any arbitrary axis perpendicular to the magnetic field. Some formulae including third order effects in C_z are also given. It is shown that an experimental study of the dependence of this splitting on the angles of rotation about any two arbitrary mutually perpendicular axes is sufficient, when second-order effects are measurable, to yield the values of $|C_z|$, η and the orientation of the principal axes of the electric field gradient tensor at the nuclear sites. In the case that the direction of one of the principal axes is known from crystal symmetry, a single rotation about this axis gives the complete information. A new method of determining nuclear spin I is proposed which depends on comparing first- and second-order shifts of the resonance frequencies of the strong inner line components. The method will be of interest in those cases where the total number $2I$ of line components cannot be unambiguously ascertained owing to the outer line components being excessively broadened and weakened by crystal imperfections. A.

538.222

6948. Second order nuclear quadrupole effects in single crystals. II. Experimental results for spodumene. H. E. Petch, N. G. Cranna and G. M. Volkoff. *Canad. J. Phys.*, **31**, 837–58 (*July*, 1953).

Experiments on the splitting of the Al^{27} resonance absorption line in a single crystal of $LiAl(SiO_3)_2$ (spodumene) are described, and are used to illustrate the second-order theory of Pt I. $|eQ\phi_{zz}/h|$ for Al^{27} nuclei in spodumene is found to be 2950 ± 20 kc/s. $\eta \equiv (\phi_{xx} - \phi_{yy})/\phi_{zz}$ at Al sites is found to be 0·94 ± 0·01. The x principal axis (corresponding to the smallest eigenvalue ϕ_{xx}) of ϕ_{ij} at the Al sites is found to coincide with the b axis of the monoclinic spodumene crystal. The other two principal axes lie in the ac plane with the y axis (corresponding to the intermediate eigenvalue ϕ_{yy}) making an angle of 56° ± ½° with the crystal c axis towards the a axis. The y principal axis at the Al sites and the z principal axis at the Li sites appear to point at the projection of the nearest oxygen ion in each case. The new method of spin determination proposed in Pt I is checked by confirming the known value $I = 5/2$ for Al^{27}. A.

538.222

6949. Adiabatic demagnetization of chromium methylamine alum. D. de Klerk and R. P. Hudson. *Phys. Rev.*, **91**, 278–81 (*July* 15, 1953).

Adiabatic demagnetization experiments have been performed on a specimen of methylamine chromic alum, $CH_3NH_3.Cr(SO_4).12H_2O$, comprising a spherical mass of small crystals. Using fields up to 23 000 oersteds and starting temperatures of the order of 1·15°K, the "free-spin" entropy of $R \log_e 4$ could be reduced to $0{\cdot}26R$, and the magnetic susceptibility v. entropy relation has been obtained over this range of entropy. The susceptibility was measured at 210 c/s with an a.c. mutual inductance bridge. For temperatures above 0·1°K very good agreement is obtained between these results and the Hebb–Purcell theoretical curve with a value of 0·275° (0·19 cm^{-1}) for the crystalline field splitting of the ground level of the Cr^{+++} ion. In the neighbourhood of entropy $R \log_e 2$ the susceptibility begins to increase rapidly and goes through a maximum at $S = 0{\cdot}53R$. As in the case of other paramagnetic alums investigated, a.c. losses occur in the region of maximum susceptibility (the loss component also showing a maximum), and ballistic measurements show hysteresis effects occurring on the low entropy side of the susceptibility maximum.

538.22

6950. The theory of magnetic resonance experiments on salts of the rare earths. R. J. Elliott and K. W. H. Stevens. *Proc. Roy. Soc. A*, **218**, 553–66 (*July* 22, 1953).

A general account is given of the theory of paramagnetic resonance in rare-earth crystals, assuming that the crystalline electric field splitting is less than the spin-orbit splitting. The treatment is related, as far as possible, to numerical parameters, which are sufficiently comprehensive for it to be a straightforward process to pass from a given crystalline field to the spin-Hamiltonian.

538.222 : 536.413 : 536.631 : 537.311.33 : 548.736.

6951. Study of the development of some properties of vanadium oxide in the neighbourhood of its transformation temperatures. M. Foex, S. Goldsztaub, R. Wey, J. Jaffray, R. Lyand and J. Wucher. *J. Rech. Cent. Nat. Rech. Sci.*, **4**, 237–59 (*Dec.*, 1952). *In French.*

Describes the results of comprehensive investigations of the following physical properties of V_2O_3 over the temperature range 100°–1000°K: thermal expansion, electrical resistance, crystal structure, specific heat, magnetic susceptibility. The changes of these properties near the principal magnetic transformation temperature (168°K) were studied, and the existence of other transformations at higher temperatures was revealed by the various measurements.

E. P. WOHLFARTH

538.222 : 539.133

6952. Paramagnetic resonance and covalent bonding. J. Owen and K. W. H. Stevens. Letter in *Nature [London]* **171**, 836 (*May* 9, 1953).

A hyperfine structure of 16 lines is observed in the paramagnetic electron resonance of dilute $(NH_4)_2IrCl_6$ which are more than to be expected for a spin 3/2 for Ir but can best be explained if the unpaired electron is partly located on the Cl, spending about 3% of its time on each.

D. H. WHIFFEN

538.222 : 548.736.3

6953. Lattice constants and magnetic susceptibilities of solid solutions of uranium and thorium dioxide. E. Slowinski and N. Elliott. *Acta cryst.*, **6**, 768–70 (*Nov.*, 1952).

Thorium and uranium dioxides are miscible in all proportions. Solid solutions may be prepared by fusion in borax at 1000–1200°C, and the lattice constants of the cubic crystals are those predicted by

ard's rule. Magnetic susceptibilities of these utions obey the Weiss–Curie law. The magnetic nent of the U^{4+} ion decreases with dilution, and roaches the "spin-only" value, a result in agree- nt with the observations of other investigators. A.

538.224

4. Magnetic study of some forms of corundum. RAMACHANDRA RAO AND M. LEELA. Letter in *r. Sci.*, **22**, 72–3 (*March*, 1953).

Reports measurements of the principal magnetic ceptibilities of natural and synthetic ruby and thetic white sapphire crystals. E. P. WOHLFARTH

538.224 : 539.13

5. The diamagnetic anisotropy of large aromatic ems. V. Interpretation of the results. R. WEENY. *Proc. Phys. Soc.* [*London*] *A*, **66**, 714–20 g., 1953).

For Pt IV, see Abstr. 326 (1953). Calculated values $\Delta\chi$ of a large number of molecules have been efully examined: the diamagnetic anisotropy of a lecule is clearly related to certain features of its icture. A preliminary interpretation of this tionship is attempted, in the light of a revised ence bond theory at present being developed by the hor. The observed effects of structural change are n discussed at a more fundamental level in terms the system of bond orders. Certain features of the rk which are of importance in the study of carbon cks and cokes are briefly pointed out. A.

538.224 : 539.185.9

6. The effect of neutron bombardment upon the gnetic susceptibility of several pure oxides. J. D. CLELLAND AND J. J. DONOGHUE. Letter in *J. appl. ys.*, **24**, 963 (*July*, 1953).

Reports measurements on fused and crystalline O_2, Al_2O_3 (alumina and sapphire), MgO and $gO.3 \cdot 5Al_2O_3$ (spinel), the diamagnetic susceptibilities ng obtained without irradiation and with integrated utron fluxes $0 \cdot 51$ and $3 \cdot 76 \times 10^{19}$ nvt. The irradia- n causes in some cases the production of lattice ects giving rise to spin paramagnetism, so that the magnetic susceptibility is reduced numerically; the parent defect concentration per molecule may be luced from the measurements. E. P. WOHLFARTH

538.23 : 621.317.43

7. Alternating-current energy losses in iron inations at magnetic saturation. F. BRAILSFORD D C. G. BRADSHAW. Letter in *Nature* [*London*] , 35–6 (*July* 4, 1953).

Describes the method of measurement and gives ults for a sample of dynamo iron containing 5% Si. Curves are given showing the total iron s, the iron loss corrected to sinusoidal flux density d the hysteresis loss as a function of B_{max}; the steresis loss was found to reach a saturation value ~ 9 W/kg at $\sim 2 \times 10^4$ gauss. E. P. WOHLFARTH (R)

538.24

8. New investigations on nuclei of reverse mag- ization. C. GREINER. *Ann. Phys.* [*Leipzig*] **12**, . 1–3, 89–110 (1953) *In German.*

In contrast to the measurements by Döring and ake (1938) the new measurements on ferromagnetic es (60% Ni–Fe) indicate that there is not always a linear dependence between the starting field strength H_s and the reciprocal of the diameter d of the nuclei in the case of 180° Bloch walls. There is, further, no unique relation between H_s and d if the measurements are carried out on nuclei formed in different main fields. The diagram due to Döring (1938) describing the growth of the nuclei is amended to account for the new measurements. E. P. WOHLFARTH

538.24

6959. Some magnetic properties of gadolinium metal. J. F. ELLIOTT, S. LEGVOLD AND F. H. SPEDDING. *Phys. Rev.*, **91**, 28–30 (*July* 1, 1953).

The saturation magnetization of gadolinium has been found to follow a $T^{\frac{3}{2}}$ law between 20–250°K. The saturation magnetization at absolute zero, determined by extrapolation is $253 \cdot 6 \pm 0 \cdot 9$ c.g.s. units, corresponding to $7 \cdot 12$ Bohr magnetons. The data fall considerably below the theoretical curve prodicted by the Debye quantum modification of the Weiss theory of ferromagnetism for the $^8S_{7/2}$ state. Curie point determinations have also been made. A.

538.24

6960. The spontaneous magnetization of alloys. I. Copper nickel alloys. D. J. OLIVER AND W. SUCKSMITH. *Proc. Roy. Soc. A*, **219**, 1–17 (*Aug.* 11, 1953).

The spontaneous magnetization is of fundamental importance in the theory of ferromagnetism but only meagre experimental data are at present available. The paper describes the initial stage of a project to determine the temperature variation of spontaneous magnetization for a number of ferromagnetics. It is impossible to deduce the spontaneous magnetization unequivocally over the complete temperature range from purely magnetic measurements, so that a determination of the magnetocaloric effect must also be made. An alloy from the system copper-nickel (23·9 atomic % copper, rest nickel) was chosen for the first investigation. An apparatus was constructed which enables the temperature rise in the magnetocaloric effect (ΔT) to be measured accurately over a wider temperature range than hitherto. The overall sensitivity is 1000 mm/°C. The specific intensity of magnetization (σ) was obtained by using the balance devised by Sucksmith (1939). Both the sets of measurements were made at closely spaced intervals up to the Curie point and, in the case of the magnetocaloric effect, considerably above this. In addition, the susceptibility above the Curie point was measured from 170 to 775°C and was found to obey the Curie–Weiss law $\chi = C/(T - \theta)$ over most of this range with $C = 3 \cdot 90 \times 10^{-3}$ and $\theta = 111$°C. The three methods of deducing the spontaneous magnetization from observations are critically discussed in general, and then in relation to the particular results obtained, which are similar to those obtained for other materials except that the dependence of the temperature rise on σ^2 above the Curie point is not linear. This is a new feature which it is considered may have important theoretical consequences. The values of the spontaneous magnetization deduced from purely magnetic measurements are in agreement, but these differ from the values obtained by using the magnetocaloric effect. The spontaneous magnetization-temperature curve deduced from the magnetocaloric effect lies

below that obtained from magnetic measurements in the immediate neighbourhood of the Curie point, and is notable for the absence of any "tail." The departure of the reduced σ against T curve from the law of corresponding states is firmly established by the present work in which the purely magnetic measurements are in fair agreement with earlier investigations. A.

538.24 : 548.7

6961. The influence of domain structure on the magnetization curves of single crystals. E. W. Lee. *Proc. Phys. Soc.* [*London*] *A*, **66**, 623–30 (*July*, 1953).

It is pointed out that the lack of agreement between theoretical and experimental magnetization curves found for single crystals in low fields is probably caused, not by residual internal strains, but by neglect of the domain structure of the crystal in the theoretical calculations. Using Néel's model for the domain structure of a single crystal of iron in the form of a strip parallel to the [110] direction magnetization curves have been calculated taking the domain structure into proper account. It is found that the (I, H) curves depend explicitly on the width of the crystal. Comparison is made between the calculated curves and the experimental results of Williams. The agreement between the two is good. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3

6962. General solutions of Maxwell's equations. E. Durand. *C.R. Acad. Sci.* [*Paris*] **236**, 1407–9 (*April* 8, 1953) *In French.*

De Broglie's equations are deduced by a new method and generalized to the case in which charges and currents in the interior of the volume under consideration are given as arbitrary functions of time. L. PINCHERLE

538.3 : 530.12

Electromagnetism and gravitation. *See Abstr.* 6446

538.3 : 539.3 : 532.51 : 530.145

Integral representation of the field vector. *See Abstr.* 6456

538.311 : 550.837.6

Electromagnetic fields of current-carrying wires in a conducting medium. *See Abstr.* 7344

538.52

6963. Induction phenomena due to the motion of matter in primary magnetic fields and the possibility of their experimental application. I. Experimental foundation. H. Hinteregger. *Acta phys. Austriaca*, **7**, *No.* 1, 1–13 (1953) *In German.*

The various effects are systematized and simple experiments are described for the demonstration of the fundamental phenomena. L. PINCHERLE

538.52 : 550.837.6

Mutual inductance of circuits on a two-layer earth. *See Abstr.* 7345

538.52 : 621.3.014.1

6964. Current element near the edge of a conducting half-plane. R. F. Harrington. *J. appl. Phys.*, **24**, 547–50 (*May*, 1953).

The two-dimensional problem of the Maxwellian field from a line source of current adjacent to a co ducting half-plane is treated by a transform meth of solution. Expressions in the form of conto integrals are given for the current induced in conductor and for the radiated field.

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561 : 537.533.7 : 621.385.1.022

6965. Space-charge waves in electron strean J. Labus. *Elektrotech. Z.* [*ETZ*] *A*, **74**, 129– (*March* 1, 1953) *In German.*

For background see Abstr. 4834 (1953). T possible consequences for noise theory of the autho recent analysis of wave motion on electron beams s finite magnetic fields are briefly indicated. Existi experimental results do not give enough informati to estimate the magnitude of the corrections.

A. H. W. BE

538.561 : 621.385.1.022

6966. Equations for the oscillations in a homogeneo flow of electrons. Yu. A. Katsman. *Zh. tekh. Fi* **22**, *No.* 9, 1467–76 (1952) *In Russian.*

The apparent aim of the article is to evolve simplifi equations for the oscillations in a flow of electron which would be applicable to high-frequency electron generators, by making use of the simplifying assum tions which seem to be justified from the theoretic analysis and from the practical records of workin The problem is reduced to a one-dimensional proble of the axial flow of electrons of variable velociti The relevant variables, such as the velocity and t density of the electrons, and the intensity of t electric field, are resolved in the usual way into co stant and variable components. Two cases a considered separately: the case of small disturbance where the products of variables are of second ord of magnitude and can therefore be neglected, and t case of large disturbances, where these terms must taken into account. In both cases the tentati solutions are expressed in the form of Fourier serie For the first case the final solution is obtained in a explicit form. For the second case the problem solved analytically up to a certain point, and aft this graphical methods are used, owing to the con plexity of the formulae. In both cases the solution for the density of electrons have a number of root which indicates the existence of stratifications. A the end of the paper, a very brief reference is made t the author's experiments which, in his opinion, gav some confirmation of the results of his analysis.

N. S. JAPOLSK

538.565 : 535.22

Proposed use of a cylindrical surface wave resonato for the determination of the velocity of short electro magnetic waves. *See Abstr.* 6581

538.56

6967. On the non-existence of surface waves Sommerfeld. P. Poincelot. *Ann. Télécomm.*, 206–11 (*June*, 1953) *In French.*

The theory of Sommerfeld (1909), which lead to th

oduction of the *Oberflächenwelle*, is critically mined, and it is concluded that such surface ves do not exist. The discussion involves, for the st part, a study and physical interpretation of ain contour integrals. L. S. GODDARD

538.566 : 548.7 : 535.135

ropagation of electromagnetic waves through a stal plate. *See Abstr.* 6576

538.566 : 621.396

8. The 10th General Assembly of the International entific Radio Union. *Onde élect.*, **33**, 127–90 *arch*, 1953) *In French.*

A series of reports summarizing the work of the ious commissions and prepared by French dele- es. For abstracts see Abstr. 6387, 6973, 6975, 7367 53). Papers not abstracted: *The 10th General sembly of the U.R.S.I.* [*Introduction*], P. Lejay 7–33); *Measurements*, J. Voge (134–5); *Theory of rmation*, A. Blanc-Lapierre (182–7); *Electronics*, Blanc-Lapierre (188–90).

538.566

9. The Fabry–Perot interferometer at millimetre velengths. W. CULSHAW. *Proc. Phys. Soc. ndon*] *B*, **66**, 597–608 (*July*, 1953).

The design and operation of an interferometer of Fabry–Perot type at wavelengths around 8 mm discussed. The reflectors have been made using ltiple quarter-wavelength sheets of dielectric, and remely sharp fringes have been obtained giving ctivity or Q factors exceeding 60 000. The effects diffraction on the interferometer are discussed and velength measurements made at various positions. e frequency of the millimetre wave source has been bilized to a high degree and the wavelength asurements at wider reflector spacings shown to ee with a substandard cavity wavemeter within accuracy attempted of a few parts in 10^5. Errors he measured wavelengths at other positions of the erferometer do not exceed a few parts in 10^4, the asured values being greater than the true value. asurements of dielectric constants and dielectric s have been made using the interferometer, and ults are in agreement with values obtained by er methods. Since the interferometer is the free- ce analogue of the cavity wavemeter it is parti- arly suitable for measurements on materials of low s tangent at millimetre wavelengths. Finally, the of the interferometer for length measurements is ntioned, and also its possible use for the accurate ermination of the velocity of electromagnetic waves. A.

538.566 : 621.392.26

0. Modes in wave guides containing ferrites. L. KALES. *J. appl. Phys.*, **24**, 604–8 (*May*, 53).

When a static magnetic field is applied in the longi- linal direction to a waveguide containing a ferrite terial, the medium within the guide becomes sotropic. It has been shown by Polder that when icrowave field is propagating within such a medium, relation between the components of **B** and **H** is en by: $B_x = \mu H_x - j\mu' H_y$, $B_y = j\mu' H_x + \mu H_y$, $= H_z$, where μ and μ' depend on the static magnetic field. Using these equations, an investigation of the waveguide modes is made. Formal solutions are obtained for guides having circular symmetry. These solutions depend on the solution of some rather involved eigenvalue equations which determine the propagation constants, and which probably can be solved only by numerical methods. A.

538.566 : 621.396.67

6971. The radiation fields of a horizontal dipole in a semi-infinite dissipative medium. J. R. WAIT. Letter in *J. appl. Phys.*, **24**, 958–9 (*July*, 1953).

The calculations of Abstr. 1785 (1953) are extended by including the effects of the displacement currents in the insulating medium.

538.566.2 : 621.396.11 : 621.392.2

6972. The electromagnetic transmission characteristics of the two-dimensional lattice medium. H. S. BENNETT. *J. appl. Phys.*, **24**, 785–810 (*June*, 1953).

This paper investigates the behaviour of the two-dimensional lattice medium in the presence of electromagnetic energy. The conditions for transmission of energy by the medium are derived and studied. In particular, the effects of the various parameters of the problem (e.g. obstacle size, obstacle shape, obstacle spacing, polarization of the electromagnetic energy) on the average propagation constant and impedance function of the medium are considered. The Wigner–Seitz cellular method is applied to the solution of the boundary value problem involving a lattice of elliptic cylindrical obstacles. Various approximate solutions are studied and appropriate functions formulated. Calculations are shown using some of these functions. Practical applications of the theoretical results are indicated, and suggestions for further research are enumerated. A.

538.566.2 : 621.396.11

6973. The troposphere and wave propagation. J. VOGE. *Onde élect.*, **33**, 136–50 (*March*, 1953) *In French.*

Summary of proceedings of Commission II at 10th General Assembly U.R.S.I. (Sydney, 1952). Topics discussed include: the propagation of metre, dm- and cm-waves to distances within and beyond the horizon, the correlation of v.h.f., propagation with meteorological conditions in the lower atmosphere, the influence of terrain on propagation, radar detection of rain and thunderstorms.

W. J. G. BEYNON (R)

538.566.3

6974. General expression for the conductivity tensor and the dielectric tensor in an ionized layer. Various applications: Hall effect and generalization of the Langevin formula of mobility. T. KAHAN AND R. JANCEL. *C.R. Acad. Sci.* [*Paris*] **236**, 1478–81 (*April* 13, 1953) *In French.*

Continuation of previous note [Abstr. 5594 (1953)] showing how to evaluate a first-order approximation for the distribution function of electrons in an ionized gas under the action of crossed magnetic and electric fields. Expressions are given for the speed of electron

diffusion, conductivity tensor, dielectric tensor, Hall coefficient and a generalized form of Langevin's formula. G. M. BROWN

538.566.3

6975. Alternative developments of the theory of radio wave interaction. L. G. H. HUXLEY. *Proc. Roy. Soc. A*, **218**, 520–36 (*July* 23, 1953).

New laboratory measurements on the motions of slow electrons in air [Abstr. 6901 (1953)] suggest alternative developments in detail of the theory of radio-wave interaction. One alternative development appears to be in better accordance with the results of measurements of radio-wave interaction using large powers, than the other. A.

538.566.3 : 621.396.11

6976. The ionosphere and wave propagation. D. LÉPÉCHINSKY. *Onde élect.*, **33**, 151–64 (*March*, 1953) *In French.*

Summary of proceedings of Commission III at 10th General Assembly of U.R.S.I. (Sydney, 1952). Subjects covered include, ionospheric winds, ionospheric conductivity, ionospheric storms, radio propagation by way of ionospheric scattering, wave interaction in the ionosphere, l.f. propagation.

W. J. G. BEYNON (R)

MAGNETIC EFFECTS 538.6

538.632

6977. Hall effects of the cobalt nickel alloys and of Armco iron. S. FONER AND E. M. PUGH. *Phys. Rev.*, **91**, 20–7 (*July* 1, 1953).

Experimental investigations of the Hall effects in cobalt, the cobalt-nickel alloys and Armco iron are described in detail. Precision measurements were made with magnetic fields up to 30 kilogauss in order to separate the ordinary and extraordinary effects. The ordinary effect in all the Co–Ni alloys was found to be negative and agreed within a factor of two with values expected from only 4*s* band conductivity. The ordinary effect in Armco iron was positive, indicating hole conduction in the 3*d* band. The field parameter α was observed to be small and negative for most of the cobalt rich alloys, while it was positive for the nickel rich alloys and Armco iron. The limitations in the use of the simple two-band model for explaining the data are outlined. No explanation of α is given. A.

538.632

6978. On the theory of the isothermal Hall effect in semiconductors. P. C. BANBURY, H. K. HENISCH AND A. MANY. *Proc. Phys. Soc.* [*London*] *A*, **66**, 753–8 (*Aug.*, 1953).

The theory is re-examined taking into account the finite dimension of the specimen in the direction of the Hall e.m.f. This involves consideration of concentration gradients, space charges, recombination processes and floating potentials at the Hall electrodes. The analysis leads to recommendations concerning experimental technique. A.

MOLECULAR AND ATOMIC STRUCTURE 53

THEORY OF SOLID STATE 539.11

539

6979. Statistical theory of frequency changes in normal modes of a solid with temperature and volu P. G. BORDONI. *Ricerca sci.*, **23**, 390–6 (*March*, 19 *In Italian.*

The relation between the isothermal freque changes, and those at constant pressure, is deri for a solid from its equation of state, taking i account the quantum character of energy distributi and assuming that the Grüneisen coefficient depe upon state of the solid only through the values frequency; the frequency changes at constant press are related to temperature by a general law which checked by several experimental proofs.

539

6980. The interaction of electrons with latt vibrations: radiation by a fast electron. M. BUCKINGHAM. *Proc. Phys. Soc.* [*London*] *A*, 601–7 (*July*, 1953).

The interaction of a single electron with the field the lattice vibrations is examined classically and t rate of radiation of energy by an electron movi faster than the velocity of sound is calculated. T agrees in the high velocity limit with a simple perturb tion theory result. The interaction between a pair electrons, due to this field, is also discussed.

539.11 : 537.2 : 538.2 : 535.3

6981. Physics of the solid state. Physical Soci spring meeting. F. E. HOARE. *Nature* [*London*] **17** 1055–7 (*June* 13, 1953).

Three sessions were held under the titles "T analysis of magnetization curves," "The band theo of metals" and "Luminescence and ferroelectricity The first two sessions dealt with the correlation experimental and theoretical work. The limitatio imposed on much of the former were discussed a indications given of the directions in which extensi is required to give a satisfactory basis for comparis with experiment. The final session summarized ma experimental results for non-metallic solids, an inte pretation of some of these in terms of a simple ba theory being presented in the introductory pape New measurements of electric hysteresis effects potassium and sodium niobates were reported.

F. E. HOA

539.12 : 533

The molecular polarization of compressed non-pol gases. *See Abstr.* 6549

MOLECULAR STRUCTURE 539.13

539.1

6982. The forces between hydrogen molecule A. A. EVETT AND H. MARGENAU. Letter in *J. chem Phys.*, **21**, 958–9 (*May*, 1953).

As earlier calculations of H_2–H_2 interaction gav reasonable results only, if a very big effective nucle

rge were assumed, it was recalculated on the is of the nuclear charge of the isolated molecules. e total interaction energy (exchange, van der Waals l quadrupole energies) is plotted for the various ative orientations of the two molecules, and also weighted average value over all these orientations a function of molecular distance. There is good eement with semi-empirical results. A. J. TAYLOR

539.13

3. The intermolecular force constants of fluorine. White, J.-H. Hu and H. L. Johnston. *J. chem. ys.*, **21**, 1149–52 (*July*, 1953).

The intermolecular force constants of gaseous orine have been determined from measurements of second virial coefficients in the region 80–300°K. the assumption that gas imperfection results only m binary collisions of spherical nonpolar molecules ose potential is of the form given, the force nstants obtained were $r_0 = 3{\cdot}61 \pm 0{\cdot}04$ Å and $k = 121 \pm 3$°K. These force constants yield cosities in good agreement with the experimental ta of Kanda if the high temperature point is carded. A.

539.13

4. A molecular theory of stress relaxation in lvmeric media. K. W. Scott and R. S. Stein. *chem. Phys.*, **21**, 1281–6 (*July*, 1953).

The application of the kinetic theory of rubber sticity to the description of the relaxation of cross-ked networks is only permissible in cases where rate-determining process is slow compared to the e of diffusion of the polymer chains. Relaxation ulting from chemical reactions causing breaking of twork crosslinks and formation of new crosslinks a process of this type. A differential equation is pposed which describes the rate of relaxation in ms of the rates of the molecular processes. A plified solution of this equation is given, and the nsequences of the solution are discussed. A.

539.13

5. A nuclear magnetic resonance investigation of ee solid benzenes. E. R. Andrew and R. G. des. *Proc. Roy. Soc. A*, **218**, 537–52 (*July* 23, 53).

See also Abstr. 4267 (1953). The nuclear magnetic cnance absorption spectrum and the spin-lattice laxation time have been measured for the protons in H_6, C_6H_5D and $1{\cdot}3{\cdot}5$–$C_6H_3D_3$ in polycrystalline m between 75 and 278°K. For all three species measured spectrum has its full rigid lattice width low 90°K. A method of analysis is developed ich makes it possible to derive separately the intra-olecular and the intermolecular contributions to the ond moment (mean square width) of the spectrum m the measured second moments, without the cessity of knowing the crystal structure. From the ramolecular contribution it is found that the paration of neighbouring protons in the C_6H_6 olecule is $2{\cdot}495 \pm 0{\cdot}018$ Å. The intermolecular ntribution is in agreement with a value calculated m a knowledge of the crystal structure. On rming from 90 to 120°K the spectrum for all three cies narrows considerably. From 120°K to the lting-point (278·7°K) the second moments remain almost constant. The second moment separation procedure is also applied in this range and leads to the conclusion that the narrowing is caused by reorientation of the molecules about their hexad axes in the crystal lattice. Analysis of the measurements of the spin-lattice relaxation time shows that for all three species the reorientation process is governed by an activation energy of $3{\cdot}7 \pm 0{\cdot}2$ kcal/mole. The reorientation frequency is of the order of 10^4 c/s at 85°K and rises to a value of the order of 10^{11} c/s just below the melting-point. The relationship between the present experimental results and recent measurements of the Raman spectrum of solid benzene is discussed. Finally, consideration is given to the application to other materials of methods of separating the intra- and intermolecular contributions to the second moment. [See also Abstr. 6161 (1953).] A.

539.13 : 533.7

6986. Thermal diffusion and force between unlike molecules. B. N. Srivastava and M. P. Madan. Letter in *Curr. Sci.*, **22**, 71–2 (*March*, 1953).

Values for the force constants in the Lennard-Jones 12 : 6 potential energy function are deduced for several pairs of gases from experimental data on thermal diffusion and inter-diffusion, and are compared with the values calculated from the force constants for like molecules. E. H. SONDHEIMER

539.132

6987. A molecular sum rule. D. ter Haar. *Proc. Roy. Soc. Edinburgh, A*, **63**, *Pt IV*, 381–4 (1952).

In connection with a discussion of dissociation equilibria in interstellar space, Kramers and ter Haar came across the following sum rule in 1946. If λ is the molecular orbital quantum number, $\lambda = 0, 1, 2, \ldots$ corresponding respectively to $\sigma, \pi, \delta, \ldots$ states, we have the selection rules $\Delta\lambda = 0, \pm 1$, and if the oscillator strengths are denoted by f, we have the following relations:

$$\sum_{\Delta\lambda=-1} f = \frac{1-\lambda}{3}, \quad \sum_{\Delta\lambda=0} f = \tfrac{1}{3}, \quad \sum_{\Delta\lambda=+1} f = \frac{1+\lambda}{3}.$$

A derivation is given of this rule. A.

539.132

6988. On the definition of atoms in the molecule and the systematization of diagrams. A. Laforgue. *C.R. Acad. Sci.* [*Paris*] **235**, 1299–301 (*Nov.* 24, 1952) *In French.*

A generalization of ideas introduced [*J. Chim. phys.*, **49**, 546 (1952)] for molecular functions based on atomic ones in stationary states. J. JACOBS

539.132

6989. On the validity of the method of variations. A. Laforgue. *C.R. Acad. Sci.* [*Paris*] **236**, 1356–8 (*March* 30, 1953) *In French.*

The distance D in function space between an approximate and the exact wavefunction is related to the error δH in the energy. Adopting D as a criterion, the author concludes that in the majority of cases, improvement in the approximate wavefunction is accompanied by a simultaneous improvement in the energy. That exceptions exist is shown in a study of H_3^+. H. H. GREENWOOD

539.132

6990. On the importance of the most probable electron configuration in the study of electronic systems. C. VROELANT. *C.R. Acad. Sci.* [*Paris*] **236,** 1666–8 (*April* 27, 1953) *In French.*

If ψ is the electronic wave function in a certain system, then the most probable configuration is defined as the set of electronic positions and spins making $\psi^*\psi$ a maximum. Away from this configuration ψ vanishes rapidly. The concept of electrons belonging to an atomic shell, or a molecular bond, corresponds to the position of one or more electrons of the most probable configuration and of neighbouring ones. J. JACOBS

539.132

6991. The most probable electron configurations in atoms and molecules. C. VROELANT. *C.R. Acad. Sci.* [*Paris*] **236,** 1887–90 (*May* 11, 1953) *In French.*

See preceding abstract. Rules are set up for the correlation between electrons of like and unlike spins in the most probable configuration. These determine *a priori* the spatial distribution of electrons around one or more nuclei. J. JACOBS

539.132

6992. Analytical wave functions for methane and the ammonium ion. M. J. M. BERNAL. *Proc. Phys. Soc.* [*London*] *A*, **66,** 514–18 (*June*, 1953).

Analytical antisymmetric wave functions for the ground states of CH_4 and NH_4^+, and the corresponding C–H and N–H bond lengths have been obtained. These were calculated by a method which is essentially an application of the variational principle to the procedure used by Buckingham, Massey and Tibbs in their calculation of a self-consistent field for methane. The calculated C–H bond length is in good agreement with the experimental value. No experimental value for the N–H bond length in the free ammonium ion is available. However, the calculated value differs by only about 5% from the experimental value of the N–D bond length in ND_4Cl. The wave functions should form useful first approximations in future calculations of the physical and chemical properties of CH_4 and NH_4^+. The NH_4^+ function has already been used as a first approximation in a self-consistent field calculation at present in progress. A.

539.132

6993. On an application of the Fermi–Thomas method to molecules. W. A. BOWERS. Letter in *J. chem. Phys.*, **21,** 1117–18 (*June*, 1953).

Equilibrium formulae are deduced from March's tables for the equilibrium internuclear distance D and the force constant k for the totally symmetric vibration of spherically symmetric molecules in terms of N, the total nuclear charge on the outer atoms, and Z, that on the central atom. The results obtained by application to a series of tetrachlorides and bromides are in bad agreement with the data. By using instead experimental bond lengths to define D a value may be calculated for the effective nuclear charge N_{eff} on the outer atoms which incorporates the shielding effect of the inner shell electrons. Much better values are then obtained for k with increasing accuracy for heavier molecules. H. H. GREENWOOD

539.

6994. Quantum theory of the hydrogen fluo molecule. D. KASTLER. *C.R. Acad. Sci.* [*Paris*] 1271–3 (*March* 23, 1953) *In French.*

The bond energy, the dipole moment and the w function of HF are calculated. All electrons are ta into account and the combination of six molec configurations is considered. For fluorine the C son–Duncanson orbitals are used as well as orthogonalized Slater orbitals. The two results di slightly. A. J. TAY

539.

6995. On the contribution of non-bonding electr to covalent energy, exemplified by the hydro fluoride molecule. D. KASTLER. *C.R. Acad.* [*Paris*] **236,** 1359–61 (*March* 30, 1953) *In French.*

See also preceding abstract. Quantum-mechan calculation of the bond energy of HF. This is fo to be slightly negative. A. J. TAY

539.

6996. Theory of centrifugal distortion constants polyatomic rotor molecules. D. KIVELSON AND E. WILSON, JR. *J. chem. Phys.*, **21,** 1229–36 (*July*, 19

The distortion constants $\tau_{\alpha\beta\gamma\delta}$ are expressed terms of inverse force constants and of the derivati of the inertia tensor with respect to interato parameters. Harmonic potential functions assumed. Relations that simplify the procedure obtaining the required derivatives are obtain Furthermore, rules are given that enable one to w down directly the derivatives with respect to cert common internal displacement co-ordinates. Gro theoretical considerations are used to obtain so knowledge of the distortion constants.

539.1

6997. An aid in the determination of internal pa meters from rotational constants for polyatomic mo cules. D. KIVELSON AND E. B. WILSON, JR. *J. che Phys.*, **21,** 1236 (*July*, 1953).

The rules given in a previous paper (precedi abstract) for the derivatives of the principal mome of inertia with respect to internal parameters are sho to be applicable to the problem of obtaining molecu parameters from spectroscopic moments of iner even though the conditions on the co-ordinate a are different in the two cases.

539.132 : 539.1

6998. Bond energies and bond distances of hyd carbons. G. GLOCKLER. *J. chem. Phys.*, **21,** 1242 (*July*, 1953).

The relations between carbon–carbon bond energi $[B(CC)]$ and distances $[R(CC)]$ and carbon hydrog bond energies $[B(CH)]$ and distances $[R(CH)]$ a taken to be a parabola and a straight line, respectivel $B(CC) = 1450{\cdot}762 - 1644{\cdot}151.R(CC) + 491{\cdot}93$ $R(CC)^2$ and $B(CH) = 252{\cdot}956 - 141{\cdot}721.R(CH$ yielding $B(CH) = 98{\cdot}104 - 0{\cdot}075.B(CC) + [3{\cdot}19$ $B(CC) - 246{\cdot}048]^{\frac{1}{2}}$ and $R(CH) = 1{\cdot}396 - 0{\cdot}59$ $R(CC) + 0{\cdot}261.R(CC)^2$. This system of equatio is based on the assumption that the heat of sublimati of carbon $L(C) = 169{\cdot}75$ kcal. Similar relatio with $L(C) = 124{\cdot}3$ and $135{\cdot}8$ kcal are also derived.

539.132 : 548.736.4

he arrangement of atoms in nickel carbonyl, $CO)_4$. *See Abstr.* 7327

539.132 : 548.736.4

Iolecular dimensions and angles of phosgene, Cl_2. *See Abstr.* 7328

539.132

). Vibration frequencies of the carbonyl group quinone and its derivatives. P. BARCHEWITZ, TATIBOUËT AND P. SOUCHAY. *C.R. Acad. Sci. ris]* **236,** 1652–3 (*April* 27, 1953) *In French.*

nfrared spectra were taken of solid quinone and stituted quinones. The CO distance in these apounds is smaller than in aliphatic ketones, so a t to higher frequencies of the C–O vibration uld be expected. The observed frequencies, vever, of the various compounds are all lower than se of aliphatic quinones, the position of the bands g influenced by the electronegativity of sub-ents (strongly electronegative groups diminish the rease of frequency). This suggests that vibra-s mainly originate from molecules having ionic ctures. A. J. TAYLOR

539.132

0. The ν_9 fundamental of C_2F_6. D. E. MANN E. K. PLYLER. Letter in *J. chem. Phys.*, **21,** 6–17 (*June*, 1953).

new value of 3920 cal mole^{-1} for the barrier to rnal rotation is calculated from observed infrared a. H. H. GREENWOOD

539.132

1. Classical limit of mean thermal vibration plitudes. J. C. DECIUS. Letter in *J. chem. Phys.*, 1121–2 (*June*, 1953).

he theory relating measurements of vibration plitudes, resolved along the equilibrium interatomic ctions, with the vibrational analysis involves quencies and amplitudes explicitly. If the potential rgy is written as a quadratic form in terms of eralized forces, a high temperature limit to these oretical relations appears. J. JACOBS

539.132

2. An application of perturbation theory to the nd *G* matrix method of calculating molecular vibra-n frequencies. P. W. HIGGS. *J. chem. Phys.*, **21,** 1–4 (*July*, 1953).

he *F* and *G* matrix form of the secular equation molecular vibrations may be split into two approxi-te equations, of which one has as its roots the high quencies (corresponding to relatively rigid bonds, '), the other the low frequencies (corresponding to tively weak bonds, etc.). With the aid of the nvectors of these two equations, the exact equa-n is transformed into a form which yields the rections to the approximate frequencies by a ightforward application of perturbation theory. e use of the correction terms so derived and the vergence of the perturbation series are illustrated a discussion of the totally symmetric modes of ylene. A.

539.132 : 535.343–15

Note on the vibrational spectra of $SiHCl_3$, SiH_2Cl_2 SiH_2Br_2. *See Abstr.* 6623

539.132

7003. Symmetry assignments for the first two excited singlet electronic states of the naphthalene molecule. O. SCHNEPP AND D. S. MCCLURE. Letter in *J. chem. Phys.*, **21,** 959 (*May*, 1953).

The electronic spectrum was taken. The four upper electron states in the near u.v. are described and assigned with the use of group analysis. The first excited state is found to be B_{2u}, the second B_{3u}. These statements can be reconciled with previous vapour fluorescence results by the assumption that one of the modes acts like a non-totally symmetric mode by the induction of a transition moment. A more detailed paper is in preparation. A. J. TAYLOR

539.132

7004. The electronic spectra of conjugated hydrocarbons. W. MOFFITT. *Proc. Roy. Soc. A*, **218,** 486–506 (*July* 23, 1953).

A new method for dealing with problems of electronic structure, which has been successfully applied to the ethylene molecule, is adapted to the general treatment of conjugated hydrocarbons. Since the theory underlying this method may be closely related to the method of antisymmetrized molecular orbitals, a fairly exhaustive discussion of this representation is included in the paper. It is shown how the relevant energy matrices may be assessed without too much labour and, in a final section, the theory is followed numerically, though somewhat approximately, for the simplest case of conjugation which is encountered in the allyl radical. A.

539.132

7005. Addendum to "Nuclear quadrupole spectra in two boron trialkyls." H. G. DEHMELT. *Z. Phys.*, **134,** *No.* 5, 642–4 (1953) *In German.*

See Abstr. 4949 (1953). The field gradients at the B nucleus estimated for two (BC_3) structures between which the molecule is assumed to resonate turn out to be nearly the same, so that the relative weights are not critical. The nuclear moments of $B^{10,11}$ are re-calculated to be 0·111 and $0{\cdot}053\times10^{-24}$ cm^2, allowing for Sternheimer's screening correction.

W. J. SWIATECKI

539.132

7006. Electron coupled interactions between nuclear spins in molecules. N. F. RAMSEY. *Phys. Rev.*, **91,** 303–7 (*July* 15, 1953).

In addition to the direct magnetic interaction between two nuclear spins in a molecule, the nuclei can have an effective mutual interaction as a result of the magnetic interactions between each of the nuclei and the electrons of the molecule. Although these indirect interactions are in general small, they are important in many cases, particularly as a result of the fact that the frequent collisions which characterize most nuclear paramagnetic resonance experiments cause the direct interaction to average to zero while this is not so for the indirect. In the present paper, the indirect interactions are evaluated. Contributions arise from a simple diamagnetic term, a closely related second-order orbital paramagnetism term, and terms due to the magnetic interaction of the nuclei with the electron spins. Expressions for each of these terms are given both for the general case and for the spherically

symmetric case which arises when there are many collisions. Specific numerical calculations of the various effects are given for hydrogen deuteride. It is shown for HD that the diamagnetic terms are of the order of a few tenths of a cycle per second. On the other hand, if the suitable mean energy of the molecular excited states is given the reasonable value of 1·4 rydbergs, the electron spin terms are 43 c/s, in agreement with experiment. A.

539.132

7007. Relative energies of polar and nonpolar valence bond functions and molecular orbital method. I. M. WOLFSBERG. Letter in *J. chem. Phys.*, **21**, 943 (*May*, 1953).

Introduction of configurational interaction into the MO method corresponds to an increase in the contribution of non-polar structures in the ground state in the VB treatment: the relative contribution of polar and non-polar structures depends on their diagonal energies. It is investigated here how correction terms in energies can be used in the MO method in order to get closer agreement with experiment directly. Three possibilities are investigated: (I) with the use of experimental atomic orbital energies, but theoretical values of overlap and interaction integrals, (II) by the addition of correction factors based on expansion of MO functions, and (III) with the same correction factors employed at all separations instead of at infinite separation. The calculations were carried out on H_2 and C_2H_4. For H_2 at large distances II and III approximate to I, but at small distances all depend highly on slight variations in the nuclear charge. For C_2H_4 there is good agreement and methods II and III approximate to I rather well. A. J. TAYLOR

539.132

7008. Relative energies of polar and nonpolar valence bond functions and molecular orbital method. II. M. WOLFSBERG. Letter in *J. chem. Phys.*, **21**, 943–4 (*May*, 1953).

See preceding abstract. The same methods were applied to cyclo-butadiene. Methods II and III only differ slightly in results, as the π overlap integrals are rather small. Methods I and II approximate to each other very closely. A more detailed paper is in preparation. A. J. TAYLOR

539.132

7009. LCAO self-consistent field calculations of the π-electrons energy levels and electronic structure of fulvene. G. BERTHIER. Letter in *J. chem. Phys.*, **21**, 953–4 (*May*, 1953).

The method of Parr and Mulliken is used for the calculation of the energy levels. Empirical values were taken for the dimensions of the carbon skeleton. The energy value was found to lie between those of benzene and butadiene, the ionization potential to be slightly smaller than that of butadiene. The charge distribution and the dipole moment were calculated ($\mu = 1{\cdot}13D$); the latter is much lower than that found by the usual LCAO approximation. The frequencies of electronic transitions as calculated, indicate correctly a bathochromic shift with respect to benzene and butadiene, but the actual values are too high. The predicted intensities agree with observed values. A. J. TAYLOR

539

7010. Resonance energies of benzene and butadi G. GLOCKLER. *J. chem. Phys.*, **21**, 1249–54 (J 1953).

The resonance energy of benzene based on ethane-ethylene-like Kekulé structure is 74·86 k The similar quantity for butadiene is 17·28 k These quantities are independent of the value of heat of sublimation of carbon. They are obta from the heats of atomization of the appropr molecules or from the heats of hydrogenation of pertinent related compounds. Both methods yield same results if properly applied.

539.

7011. The use of free electron model wave funct in the derivation and representation of LCAO wave functions of conjugated molecules. H. H. JA *J. chem. Phys.*, **21**, 1287–92 (*July*, 1953).

A simple relation between free electron model LCAO molecular orbital wave functions is derived linear and cyclic conjugated molecules involving branching of the π-electron system. On the basis this relation LCAO MO wave functions and th energies can be calculated without solution of secu equations or extensive numerical computations, simple analytic expressions for the wave functi and energies can be derived. The method assu equal resonance and Coulomb integrals in the c jugated system but does not require neglect of over integrals. The types of molecules for which method is most appropriate are discussed. other molecules the LCAO MO WF's derived fr FEM WF's may be improved by perturbation calcu tions. The relations are also shown to hold molecules containing heteroatoms and branch π-electron systems if the FEM WF's are replaced the FEM-like WF's derived. Finally, a sim method of graphic representation of LCAO WF's proposed and illustrated.

539.132 : 541

7012. The molecular orbital theory of chemi valency. XIV. Paired electrons in the presence of t unlike attracting centres. A. C. HURLEY AND LENNARD-JONES. *Proc. Roy. Soc. A*, **218**, 327 (*July* 7, 1953).

For Pt XIII, see Abstr. 4259 (1953). As a st towards an understanding of chemical bonds diatomic molecules which contain unlike atoms, theory of paired electrons in the presence of t unlike attractive centres has been worked out. T essential feature of the method is that the field these centres is expressed as a sum of two fields, o of which is symmetrical and the other antisymmetri in the plane midway between the two centres. formal solution having been provided in earl papers for the wave functions and energies of t electrons in the symmetrical part of the field, this used as a basis for a perturbation method to calcul the effect of the antisymmetric part of the field.

539.132 : 541.

7013. The molecular orbital theory of chemi valency. XV. Illustrative calculations of the properti of polar bonds. A. C. HURLEY. *Proc. Roy. Soc.* **218**, 333–44 (*July* 7, 1953).

The perturbation theory developed in the preced

is used to calculate the properties of a set of ecular models which are formed by continuously ing the charges on the protons of the hydrogen ecule. The binding energies and heats of reaction ll such model molecules are calculated, and it is id that the thermochemical behaviour of the lels reproduces several interesting features ob- ed in the behaviour of real molecules. For these lels the bonding energy of a molecule of type AB sually greater than the mean value of this quantity A_2 and B_2, but this is due mainly to the reduction he internuclear repulsion energy and not to the c-covalent resonance. A.

539.133

4. The structure and residual entropy of ice. E. RUNDLE. Letter in *J. chem. Phys.*, **21**, 1311 y, 1953).

ssuming that water dipoles interact to maintain maximum net dipole, that $\angle$ HOH $\simeq 104\frac{1}{2}°$ in ice that one OH-bond lies along one O–O ligand, a rdered polar structure with space group $C_{6V}4$–nc is found. A table of the positions is given.

C. TURNER

539.133

5. Some calculations on the ethylene molecule. MOFFITT AND J. SCANLAN. *Proc. Roy. Soc. A*, **218**, –86 (*July* 23, 1953).

new treatment of the structure of both planar twisted forms of ethylene is given. Attention is ised on the unsaturation electrons, to which the hod of atoms in molecules is applied. Values are ulated for the location of the $N \rightarrow V$ absorption ds, which are in good agreement with the observed ctrum. The twisting frequency is also estimated. e results obtained are uniformly better than those revious calculations. A.

539.133 : 535.343

he vibrational spectra and structure of ferrocene ruthenocene. *See Abstr.* 6618

539.133 : 539.61

urface tensions and covalent radii. *See Abstr.* 6521

539.133 : 548.737

he crystal and molecular structure of maleic acid. *Abstr.* 7337

539.133

6. Relations between moments of inertia and ation frequencies of isotopic molecules. L. M. RDLOV. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 2, –52 (1953) *In Russian.*

ibration frequencies of isotopic molecules are ject to certain rules of sums and of sums of ducts. From general considerations of the mutual endence of the parameters in the potential func- n, which relate isotopic systems, similar rules for ation frequencies are established and illustrated.

J. JACOBS

539.133

7. The anomalous structure of triphenyl methyl nide. C. STORA. *C.R. Acad. Sci.* [*Paris*] **236**, 1–4 (*April* 27, 1953) *In French.*

he linearity of the central C–Br bonds of two ghbouring molecules is shown by Paterson and arier lines through the tertiary axes, in the 3-dimensional model. The C_c–Br and Br–Br interatomic distances are anomalous. 3000 structure factors of 17 strata around the centre have been used. C. TURNER

539.133

7018. The calculation of interatomic distances. O. CHALVET AND C. VROELANT. *Cahiers de Phys.*, *No.* 40, 17–28 (*Nov.*, 1952) *In French.*

A review of problems, and of methods hitherto employed to relate bond order, bond distances and force constants. J. JACOBS

539.133 : 535.343.4–14

Microwave spectrum of fluorobenzene and formic acid. *See Abstr.* 6633–4

539.133

7019. Polarizability of the hydrogen molecular-ion. A. RAHMAN. *Physica*, **19**, 145–65 (*March*, 1953).

The electric polarizability of the hydrogen molecule-ion has been calculated using as a basis the rigorous solution of the Schrödinger equation for H_2^+. The energy of polarization has been calculated by means of exhaustive variation functions involving 9 terms for the parallel polarizability and 6 terms for the perpendicular case; it is shown that to an accuracy of four decimal places the convergence with the above chosen variation functions is complete. An analytical method is developed to show the form of the variation function for the calculation of the polarizability and hence making the choice of terms for inclusion in the variation function not entirely empirical. The first two derivatives of the polarizability with respect to the internuclear distance are calculated. On the basis of data available up to date it is shown that if the parallel polarizability is calculated by means of Schrödinger second-order perturbation theory then the convergence is extremely rapid. The polarizability calculated on the basis of inaccurate unperturbed wave functions can deviate considerably in both directions from the true value. The case of the hydrogen molecule is discussed and it is concluded that even the best wave functions available for this molecule are not sufficiently accurate for the purpose. A Morse type potential has been fitted for the energy of the molecule-ion, and it is shown that the anharmonicity of this potential plays an important role in the calculation of the transition moments even for the lowest vibrational states of the nuclei. A.

539.133

7020. Accuracy of perturbation calculated from inaccurate unperturbed wave function (with special reference to electric polarizability of molecules). A. RAHMAN. *Physica*, **19**, 377–84 (*May*, 1953).

An analysis has been made of the relation between the inaccuracies of an unperturbed wave function Ψ and the resulting inaccuracies in the calculated energy of perturbation, when Ψ is used as the starting point. In terms of a certain integral A occurring in the calculation of the perturbation and the error ΔE in the unperturbed energy E due to the approximate nature of the unperturbed wave function Ψ, the accuracy, 1 in N, that can be claimed justifiably for the calculated value of the perturbation is restricted by the relation $N^2 \leqslant 2A/\Delta E$. In this paper A is of the form $\int \Phi(H-E)\Phi d\tau / 2\int \Phi^2 d\tau$, Φ being the function used with Ψ for calculating the perturbation. The formula limiting the value of N has been applied

satisfactorily in the case of certain recent calculations of the electric polarizability of the hydrogen molecule and the molecular-ion [see preceding abstract]. A.

539.133

7021. Electric polarization and dipole moments. N.-Q. TRINH. *Cahiers de Phys., No.* 42, 4–25 (*March*, 1953) *In French.*

The basic formulae concerning dipole moments are derived and an extensive account is given of the development of the theory. It is shown how the dipole moments and polarizations can be found by the application of Debye's relation, and by the methods of electrostriction, thermal effects in the dielectric, and dielectric losses. Some examples are given. Some remarks are made on the relation between molecular moments and bond moments.

A. J. TAYLOR

539.133

7022. Electric moments of mesomeric systems. Study of hydrocarbons with polar substituents and of heterocyclic compounds. H. LUMBROSO. *Cahiers de Phys., No.* 42, 25–42 (*March*, 1953) *In French.*

From the difference in dipole moments between substituted saturated and unsaturated compounds it is clear that resonance has to be considered in the evaluation of dipole moments. The lone pair of the substituent can interact with π electrons, so that the charge distribution is changed. If the substituent is non-linear, the direction of the moment may also be affected. Several examples are discussed, and a theoretical derivation is given of the molecular dipole moment of such molecules. It is also shown in which way these moments can be found experimentally: many examples are given. The methods available for the evaluation of the resonance effect are described. If resonance is to take place the molecule must be flat; from the experimental dipole moment it is sometimes possible to derive conclusions about the flexibility of the molecule. A. J. TAYLOR

539.133

7023. The polarizability and configuration of *n*-paraffins. R. S. STEIN. *J. chem. Phys.*, **21**, 1193–8 (*July*, 1953).

The principal polarizabilities of a flexible paraffin hydrocarbon molecule may be calculated from the bond polarizabilities. The result will depend upon the average configuration of the molecule. The light scattering depolarization which is calculated from these polarizabilities may be compared with measured values. The comparison favours a configuration requiring preferential *trans*-arrangements about carbon–carbon single bonds. A.

539.133

7024. Size and shape of macromolecules. H. W. MELVILLE. *Nature* [*London*] **171**, 1087–9 (*June* 20, 1953).

Substance of a Discourse given at the Royal Institution, March 20, 1953. Methods for the determination of the structure of linear, branched, and cross-linked polymer molecules are reviewed.

G. I. W. LLEWELYN

539.133 : 541.64

Molecular size distribution in the copolymerization on N-carboxyamino acid anhydrides. *See Abstr.* 7259

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.15 : 5

7025. Numerical methods and automatic compu in [extra-nuclear] atomic theory. A. S. DOUG *Nature* [*London*] **171**, 868–9 (*May* 16, 1953).

Report on Symposium held at Cambridge Dec. 9, 1952. Six papers were read, giving revi of the methods of solution of stationary state collision problems with accounts of recent work.

W. J. SWIATE

539.15

7026. Dilatation oscillations of nuclei. G. MA *Acta phys. Hungar.*, **3**, *No.* 1, 1–10 (1953) *In Germ*

A theoretical estimate is made of the importa of these oscillations for excitation energies aro 10 MeV. γ-Ray resonance is found to occur energies $\sim 60\,A^{-1/3}$ MeV (A = atomic weight). dependence on A is in agreement with experime the experimental value of the constant is about The discrepancy is mainly due to uncertainty in value of the "velocity of sound" in the nucleus.

L. PINCHE

539.15

7027. On a new nuclear theory. N. S. KALITZ *Acta phys. Hungar.*, **3**, *No.* 1, 45–53 (1953) *In Germa*

A classical generalization of the Maxwell–Lore electrodynamics is presented in $(5 + 1)$ dimensic It appears that a stationary "nucleon" in such space has two charges and a spin. The poten energy of 2 nucleons is $\propto e^{-\mu r}/r$ and contains spin-dependent part. W. J. SWIATE

539.15

7028. Further development of the statistical the of nuclei. P. GOMBÁS. *Ann. Phys.* [*Leipzig*] *No.* 1–3, 155–9 (1953) *In German.*

A shorter account of Abstr. 2605–6 (1953).

W. J. SWIATE

539.15

7029. The statistical model and angular distributio O. HITTMAIR. Letter in *J. Phys. Radium*, **14**, 27 (*April*, 1953) *In French.*

In reactions produced by inelastic scattering spin $\frac{1}{2}$ particles, certain angular distributions predict by the statistical model contain no energy-depend terms. Their validity then relies only on the valid of the fundamental hypothesis of the model (existe of a continuum of energy levels). For example, it shown that, when the hypothesis is valid for t target, compound and residual nuclei, the distributi of scattered particles should be always isotrop Similarly, as a special case of a second gene example, the angular distribution of 374 keV γ-ra from Pb^{204}, arising from inelastic scattering of 390 k neutrons, is evaluated. J. J. WILKI

539.152

7030. Some rules in the composition of the nucle spin and the nuclear shell model. I. A. VAÏSMA *Dokl. Akad. Nauk SSSR*, **88**, *No.* 2, 237–40 (1953) *Russian.*

A list of spins and magnetic moments and th interpretation on the basis of the orbits of Elsasser (1933). W. J. SWIATE

539.152.1

1. On the energy levels of nuclei. F. J. NIEWSKI. *C.R. Acad. Sci.* [*Paris*] **236,** 1483–4 *ril* 13, 1953) *In French.*

he previously developed formula $E_n = Kn(n+1)$ str. 372 (1953)] for the energies of (rotational) tation, E_n, of light nuclei is shown to apply also to ^{0}, Ne^{21}, Mg^{24}, Mg^{25}, Mg^{26}, Al^{28} and S^{34}, and a e is given of the corresponding moments of inertia l radii of gyration. A. O. STANESBY

539.152.1

2. Theoretical studies in nuclear structure. The matrix elements of non-central forces with an lication to the 2*p*-shell. J. P. ELLIOTT. *Proc. v. Soc. A*, **218,** 345–70 (*July* 7, 1953).

For Pt IV, see Abstr. 1162 (1952). Formulae are ived for the matrix elements of a non-central ce in a configuration of N particles, involving ctional parentage coefficients for a reduction by particles. The case when this configuration tains a number of closed shells and one unfilled ll is considered, although the methods used are plicable to less simple configurations. Specializing the single 2*p*-shell configurations $(1s)^4(2p)^m$ for ich the necessary coefficients have been derived, matrices of central, tensor and two-body spin-bit forces are given in terms of their two-particle ments. The determination of these two-particle ments is discussed and values are given for the -shell. Finally, the matrices derived are used in attempt to derive the spins and moment data of tain 2*p*-shell nuclei from a two-body charge sym-tric interaction containing central, tensor and spin-bit forces. A.

539.152.1

33. Mass surfaces. A. E. S. GREEN AND N. A. IGLER. *Phys. Rev.*, **91,** 40–5 (*July* 1, 1953).

In the light of recent experimental data smooth ass surfaces are examined which may be placed in e form $M - A = \Delta_m(A) + J(A)[D - D_m(A)]^2$, ere $\Delta_m(A)$, $D_m(A)$, and $J(A)$ are key functions ich characterize the mass surface and $D = N - Z$ the neutron excess. An attempt is made to find an timum set of key functions and to evaluate various mi-empirical key functions now in use. In this dy the reference key functions $\Delta_m(A) = - 100)^2/100 - 64$, (mMU), $J(A) = 25/A$, (mMU) d $D_m(A) = 0{\cdot}4A^2/(A + 200)$ are introduced. These ference functions are used in such a way as to ectively subject the data and various semi-empirical nctions to microscopic examination, so that "fit" comes immediately apparent. It is noted that most the semi-empirical mass surfaces in current use ve rise to large systematic errors in nuclear masses. ne large errors are not inherent properties of the mi-empirical equation since a set of constants can found which reduce these errors to within the nge of uncertainty caused by shell effects. A.

539.152.1

34. Discontinuities in the nuclear mass surface. . E. S. GREEN AND D. F. EDWARDS. *Phys. Rev.*, **91,** –53 (*July* 1, 1953).

Proton and neutron binding energies are analysed such a way as to permit an approximate assessment of the effects associated with pairing and shell structure. Several interesting conclusions are drawn with respect to the accuracy of various theoretical expressions which have been proposed for the pairing effect. Analysis of the data and considerations of an atomic model lead to a simple approximate representation of a shell stabilizing correction to nuclear energies. This shell structure term accounts rather well for the observed departures from the general trends of beta-stability, nuclear masses, and nuclear Q values. The shell correction suggests that much larger systematic variations in nuclear masses may be identified with shell structure effects than might previously have been suspected. A.

539.152.1

7035. Preferred ratios of energies of excited states of nuclei. M. G. REDLICH. *Phys. Rev.*, **91,** 328–32 (*July* 15, 1953).

For the lowest three states in the decay schemes of twenty-eight nuclei, the ratio of the larger to the smaller of the intervals between adjacent states is known within $\pm 0{\cdot}018$. Twenty ratios equal fractions with denominators 1 to 5 approximately within experimental uncertainty. Integral relations exist in the decay schemes of nuclei with two or three level pairs. Energies of the several known lines of seven nuclei are approximately integral multiples of a single energy, different for each nucleus. A.

539.152.1 : 539.165.2

7036. β-disintegrations and nuclear structure. III. Over-allowed transitions. R. BOUCHEZ AND R. NATAF. *J. Phys. Radium*, **14,** 217–25 (*April*, 1953) *In French.*

For Pt II, see Abstr. 6697 (1952). Konopinski's method of classifying β-transitions is generalized and applied particularly to over-allowed transitions between mirror nuclei and between light nuclei with $A = 4n + 2$. A comparison of the nuclear matrix element with experimental data shows that a reasonable value of the matrix element is obtained by assuming a mixture of Fermi and Gamow–Teller interactions in proportions $0{\cdot}25 \pm 0{\cdot}05$ and $0{\cdot}75 \pm 0{\cdot}05$. L. PINCHERLE

539.152.2

7037. Theory of spin-medium broadening in quadrupole resonance. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **236,** 1553–5 (*April* 20, 1953) *In French.*

There are two effects, the fluctuation of the resonance frequency due to the molecular vibrations, and the limitation of the lifetime of the excited states by the transitions due to the coupling spin-medium. The corresponding characteristic times are worked out by the methods previously employed by the author for the case of magnetic resonance [Abstr. 3434 (1953)]. Comparison of results with experimental values for I and Sb shows that the theory may be considered as a first approximation. L. PINCHERLE

539.152.2

7038. Nuclear magnetic resonance experiments on $CuCl_2.2H_2O$, $K_2CuCl_4.2H_2O$ and $(NH_4)_2CuCl.2H_2O$. J. ITOH, R. KUSAKA, Y. YAMAGATA, R. KIRIYAMA AND H. IBAMOTO. *Physica*, **19,** 415–18 (*May*, 1953).

By working at room temperature and only 1800 gauss to obtain the proton resonance spectrum,

the proton–proton interactions can be studied even in the presence of paramagnetic ions. In $K_2CuCl_4 . 2H_2O$ the H . . . H distance is 1·62 Å and the pairs of protons are directed along [110] and [1$\bar{1}$0]. The (NH_4) salt has a similar structure and in $CuCl_2 . 2H_2O$ the H . . . H directions are at ±37·5° to the *a* axis in the plane perpendicular to the *b* axis. D. H. WHIFFEN

539.152.2

7039. The spin and magnetic moment of Ca^{43}. C. D. JEFFRIES. Letter in *Phys. Rev.*, **90**, 1130 (*June* 15, 1953).

Magnetic resonance analysis of $CaBr_2$ solution with enriched Ca^{43}, mixed with a $MnCl_2$ solution (the Mn^{++} to shorten the relaxation time) containing D_2O (to give a comparison signal) can be interpreted according to the theory of F. Bloch (1950) and gives $I = 7/2$, $\mu = -1·3152 \pm 0·0002$ n.m. W. J. SWIATECKI

539.152.2

7040. Chlorine pure quadrupole resonances. D. W. MCCALL AND H. S. GUTOWSKY. Letter in *J. chem. Phys.*, **21**, 1300 (*July*, 1953).

Chlorine nuclear quadrupole resonances have been detected in several solids. The compounds and their Cl^{35} resonance frequencies (~30–40 Mc/s) are listed.

539.152.2

7041. Nuclear magnetic resonance in thallium compounds. H. S. GUTOWSKY AND B. R. MCGARVEY. *Phys. Rev.*, **91**, 81–6 (*July* 1, 1953).

A precision, resonance absorption measurement has been made of the ratio of the magnetic moments of Tl^{205} and Tl^{203}. The experimental ratio is $\mu^{205}/\mu^{203} = 1·009838 \pm 0·000001$. This result, when compared with the value observed by Berman for the ratio of hyperfine structure separations in the $^2P_{\frac{1}{2}}$ state, $\Delta\nu^{205}/\Delta\nu^{203} = 1·00974 \pm 0·00003$, establishes the reality of effects attributable to the finite nuclear size. Shifts of about 0·2% have been found in the thallium resonance position in Tl^{+3} compared to Tl^{+1} compounds. The resonance shifts in aqueous solutions varied linearly with the anion concentration. Complex formation and interionic electronic exchange interactions, respectively, account qualitatively for the observed effects. A.

539.152.2

7042. Nuclear quadrupole resonance in rhombic sulfur and the quadrupole moments of S^{33} and S^{35}. H. G. DEHMELT. *Phys. Rev.*, **91**, 313–14 (*July* 15, 1953).

Four closely spaced absorption lines due to nuclear quadrupole resonance of the S^{33} isotope have been observed near 22·9 Mc/s in a sample of rhombic sulphur, containing this isotope in its natural abundance of 0·74%. As the nuclear spin of S^{33} is $\frac{3}{2}$, these lines correspond to the transition $m = \pm\frac{1}{2} \leftrightarrow m = \pm\frac{3}{2}$ and an average quadrupole coupling constant $eQ^{33}q_{zz}/h = 45·8$ Mc/s. The bond structure of the S_8 molecule is discussed with respect to the evaluation of q_{zz}, the gradient of the electric field at the site of the nucleus. From the measured coupling constant $eQ^{33}q_{zz}$ and the calculated q_{zz}, the value $Q^{33} = -0·050 \times 10^{-24}$ cm^2 is obtained for the nuclear quadrupole moment of S^{33}. With the ratio Q^{35}/Q^{33} known from microwave data, this leads to $Q^{35} = +0·035 \times 10^{-24}$ cm^2 for S^{35}. A.

539.152.2 : 539.153 : 535.338.3

7043. On the spectroscopic determination of quadrupole moments of nuclei. I. I. GOL'DM... *Dokl. Akad. Nauk SSSR*, **88**, *No.* 2, 241–3 (1953) *Russian.*

The introduction of shielding functions of Thomas–Fermi type for closed electron shells affe estimates of $\partial^2V/\partial z^2$ at the nucleus and a se quantitative theoretical discussion indicates t quantity to be too large by 5–15% for *p* electrons a 30–40% for *f* electrons. Nuclear quadrupole mome obtained from experimental spectroscopic values s the couplings and $\partial^2V/\partial z^2$ values ignoring shielding v be correspondingly too small. D. H. WHIFF

539.1

7044. The decay of the populations of neon ato in the $2p^5 3s$ levels. D. J. ECKL. *Canad. J. Phys.*, 804–19 (*July*, 1953).

Improved apparatus has been designed to det mine the rate of decay after excitation of the popu tions of the four states in the $1s^2 2s^2 2p^5 3s$ configurati of neon. An absorption method is employe Measurements show that the population of the ^{1} state decays exponentially. The decay curves for t $^3P_2$ and $^3P_1$ states may be expressed as the sum of tw exponential rates of decay. Atoms in the $^1P_1$ sta disappear very rapidly making measurements difficu the decay is assumed to be exponential. Curves mean life as obtained from these exponentials a plotted against pressure for all four states. The initi populations of the four states, determined fro initial absorption, are of the order of 10^9 atoms p cm^3, and are plotted as a function of pressure. Withi the limits of error the populations so calculated a the same for different absorption lines.

539.1

7045. Electron excitation of forbidden lines occurrin in gaseous nebulae. M. J. SEATON. *Proc. Roy. Soc.* 218, 400–16 (*July* 7, 1953).

In a previous paper [Abstr. 3533 (1953)] th Hartree–Fock method has been used to calcula electron excitation cross-sections for the groun configuration terms of O I. In the present paper th modifications required for similar calculations o positive ions are discussed, and cross-sections an calculated for electron excitation of the ground con figuration terms of N II, O II, O III, Ne III and Si These cross-sections are of fundamental importanc in discussing the physical state and chemical com position of gaseous nebulae. A first approximation to the solution of the coupled integro-differentia equations is obtained by neglecting energy difference (the E.R. approximation). A comparison is mad between the cross-sections calculated using exac solutions of the E.R. equations and using weak coupling approximations to these solutions. It is found that, although allowance for distortion gives a considerable improvement, the weak coupling approximations cannot in general be relied upon to give accurate results. Estimates of the magnitudes of the terms omitted in the E.R. approximation are made by perturbation methods, and in all cases these terms are found to be reasonably small. Final values for the cross-sections are probably correct to within ±40% in absolute value and rather more accurate

this in the relative values. Cross-sections nated for a number of other ions of astro- ical interest are considered to be correct to in a factor of 2. Hartree–Fock wave functions N II are given in an appendix. A.

539.153 : 537.531 : 535.343

. Calculations of *K* absorption edges in some y atoms. S. BRENNER AND G. E. BROWN. *Proc. Soc. A*, **218**, 422–32 (*July* 7, 1953).

he binding energy of a *K* electron in some heavy ns is calculated to order $Z\alpha^2mc^2$. This energy is idered in three parts: (i) the potential energy of *K* electron in the Coulomb field of the nucleus, the interaction with the other *K* electron, and the Coulomb potential energy arising from the r ("outer") electrons. Although the potential to the outer electrons is large, it varies little in the on of the *K* shell and may be written in the form $= a + b(r)$, $b(0) = 0$, where a is a large constant ntial and $b(r)$ a small correction to it. For these self-consistent field calculations are used. The lear potential and a are taken into account exactly the remaining terms considered as small per- pations. The *K* electrons are treated relativistically. change in the wave functions of the outer electrons re a *K* electron is removed is shown to give only econd-order change in the binding energy of a lectron. The results are found to be in good eement with experiment. A.

539.153 : 537.531 : 535.43 : 537.533.74

7. Coherent scattering of X-rays and high-speed tron rays by atoms. The atomic form-factor. GÁSPÁR. *Acta phys. Hungar.*, **3**, *No.* 1, 59–63 53).

heoretical. The atomic form-factors based on the tron densities given by the method of the self- sistent field are generalized for elements for which self-consistent field distribution has not been rked out. J. THEWLIS

539.153 : 548.7

Vibrational modifications of the electron distribution molecular crystals. I. The density in a vibrating bon atom. *See Abstr.* 7289

539.153.4

8. On the use of a single scale factor in atomic ve functions. I. C. W. SCHERR. *J. chem. Phys.*, 1237–40 (*July*, 1953).

Single scale factors are determined for converting 2*s* and 2*p* self-consistent field orbitals of atoms in first row of the periodic table into one another. veral simple relationships are found which allow dictions for fluorine and neon. A.

539.153.4

9. On the use of a single scale factor in atomic ve functions. II. Application to overlap integrals. W. SCHERR. *J. chem. Phys.*, **21**, 1241–2 (*July*, 1953).

A method of estimation of two-centre homopolar erlap integrals between SCF atomic orbitals, due to ulliken, has been tested and verified. A.

539.153.4

50. Correlation energy in the ground state of He I. C. GREEN, M. M. MULDER AND P. C. MILNER. *ys. Rev.*, **91**, 35–9 (*July* 1, 1953).

With a view to examining the effects of configuration interaction in a simple case, the three-term and six-term expressions given by Hylleraas for the ground-state wave function of He I have been expanded in series of Legendre functions of the cosine of the angle between the two radius vectors. The coefficients in these expansions are functions of r_1 and r_2, the distances of the two electrons from the nucleus. The various component functions are presented, together with the coefficients with which these functions enter the expansions, and their contributions to the total energy. A discussion is given of the method of estimating the magnitude of the correlation, or configuration interaction, energy. Evidence is presented that the total correlation energy is at least $-0{\cdot}129R_{\mathrm{He}}hc$ and may be even more negative. Of this amount it is estimated that $-0{\cdot}056R_{\mathrm{He}}hc$ is associated with the radial part of the correlation energy, $-0{\cdot}075R_{\mathrm{He}}hc$ with the angular part, and $+0{\cdot}002R_{\mathrm{He}}hc$ with the mixed part. A.

539.154.2

7051. On the theory of the periodic system of elements. D. IVANENKO AND S. LARIN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 1, 45–8 (1953) *In Russian.*

The paper is a refinement of the approximate theory of the Mendeleev periodic system with the help of the approximate Thomas–Fermi–Dirac equation, which takes into account the effect of exchange. *f*-electrons appear first in cerium ($Z = 58$) while according to the formula $Z_l = \gamma(2l + 1)^3$, $\gamma = 0{\cdot}155$ they should appear in caesium ($Z = 55$). The relative error in the theoretical values of Z_l is larger in the region of light atoms than in the region of heavy atoms. The authors propose the view that the inaccuracy in the results is caused to a considerable degree by the fact that the exchange interaction of electrons is not taken into account in the primary model of Thomas–Fermi. E. RABKIN

539.155.1

7052. Some atomic masses for tellurium. B. G. HOGG AND H. E. DUCKWORTH. Letter in *Canad. J. Phys.*, **30**, 628–9 (*Sept.*, 1952).

The most probable masses for Te^{122}, Te^{124}, Te^{128} and Te^{130} have been computed from mass ratios and previously known masses.

539.155.1 : 539.163

7053. A mass spectrographic determination of the decay energies of Rh^{102} and Rh^{104}. B. G. HOGG AND H. E. DUCKWORTH. *Canad. J. Phys.*, **30**, 637–42 (*Nov.*, 1952).

Mass spectrographic measurements are reported of the following mass differences: $\frac{1}{2}Pb^{204}$–Ru^{102}, $\frac{1}{2}Pb^{204}$–Pd^{102}, $\frac{1}{2}Pb^{206}$–Rh,^{103} $\frac{1}{2}Pb^{208}$–Ru^{104}, and $\frac{1}{2}Pb^{208}$–Pd^{104}. These results are combined with existing transmutation data to obtain the energies available for the disintegrations $Rh^{102} \rightarrow Ru^{102}$, $Rh^{102} \rightarrow Pd^{102}$, $Rh^{104} \rightarrow Pd^{104}$, and $Rh^{104} \rightarrow Ru^{104}$. In the first three cases the energy values are in substantial agreement with those found by β-ray spectroscopy. The final disintegration, namely, $Rh^{104} \rightarrow Ru^{104}$, is found to possess enough energy for appreciable *K*-capture and a lesser degree of positron activity. These activities have not yet been observed. Atomic masses are given for Ru^{102}, Pd^{102}, Rh^{103}, Ru^{104} and Pd^{104}. A.

539.155.2

7054. Studies on isotopes. I. The isotopic composition of water which has been enriched in heavy isotopes by fractionation. H. A. E. MACKENZIE AND A. M. MILNER. *J. S. African Chem. Inst.*, **4**, 57–62 (*June*, 1951).

An attempt has been made to obviate the need for determining experimentally the individual contributions of HDO and $H_2^{18}O$ to the excess density of water samples which have been enriched in heavy isotopes by fractionation. The theory leads to the conclusion that the platage of a fractionating column is greater for the separation of $H_2^{16}O$ and $H_2^{18}O$ than it is for the separation of H_2O and HDO. By introducing a single parameter, whose value is determined empirically, into the theory of the enrichment process, it is possible to calculate the composition of water which is derived from natural water by distillation processes only, provided that its density is known.

NUCLEAR SCIENCE ABSTRACTS

539.155.2

7055. Studies on isotopes. II. The approach to isotopic equilibrium during fractional distillation with appreciable hold-up in the stillpot. H. A. E. MACKENZIE AND P. N. MALHERBE. *J. S. African Chem. Inst.*, **4**, 63–8 (*June*, 1951).

A modification of Urey's theory of the approach to isotopic equilibrium during fractional distillation, which can be employed in cases where there is appreciable hold-up in the stillpot, is shown to yield an adequate and useful representation of the facts.

NUCLEAR SCIENCE ABSTRACTS

539.155.2

7056. Studies on isotopes. III. The performance of stainless steel gauze ring packing in the isotopic fractionation of water. H. A. E. MACKENZIE AND P. N. MALHERBE. *J. S. African Chem. Inst.*, **4**, 69–78 (*June*, 1951).

A laboratory still for the rectification of water is described. The still is constructed from cheap and readily available materials and embodies accessories which give close control of throughput and pressure drop and by means of which fresh water can be fed into the column to replace the isotopically light distillate. A 12-ft rectifying section is packed with $\frac{1}{16}$-in., 100 mesh stainless steel gauze rings. The results of several distillations show that this packing may be used to achieve useful enrichments of $H_2^{18}O$ and HDO, provided that low throughputs are employed. The characteristics of the packing have been studied in detail and the column has twice been run to isotopic equilibrium. The enrichments of heavy isotopes achieved in the two cases are equivalent to increases in density of 180 and 187 parts per million. The limiting boil-up rate has been found to decrease and the efficiency of the packing to increase with usage, presumably due to a cleansing action of the steam on the stainless steel surface. The performance of the stainless steel rings is markedly inferior to that claimed for the otherwise identical phosphor-bronze rings used by Dostrovsky and Hughes. The only likely explanation seems to be that the metals have different surface characteristics. Despite this, an H.E.T.P. of as little as 1·5 in. in the case of the oxy isotopes has been achieved here.

NUCLEAR SCIENCE ABSTRA

539.1

7057. Studies in isotopes. IV. Catalysis of isot exchange between gaseous oxygen and liquid wa H. A. E. MACKENZIE AND A. M. MILNER. *J. African Chem. Inst.*, **4**, 79–83 (*June*, 1951).

Attempts have been made to catalyse the isotc exchange between oxygen and liquid water ur laboratory conditions. No appreciable excha occurs in the presence of metallic oxides or hydroxi or of organic substances capable of entering i oxidation-reduction reactions. It is establish however, that exchange does take place in the prese of H_2O_2 and of substances which catalyse the decc position of H_2O_2. Since catalase, in particular one such substance and since this enzyme exists in green plants, the fact that the oxygen produced dur photosynthesis has the same isotopic composition the water in which the plant is bathed can no lon be accepted as proof that the mechanism of pho synthesis involves the production of oxygen sol from the water. NUCLEAR SCIENCE ABSTRA

539.15

7058. Theoretical yield of a spiral thermal diffus column. P. RENAUD. *C.R. Acad. Sci.* [*Paris*] 22 1555–7 (*April* 20, 1953) *In French.*

This type of column and the approximate meth ("calcul des dissymétries") used here to determi its yield are described in *J. Chim. phys.*, **50**, 139– (*March*, 1953). The small separation obtainable in gas mixture by means of a parallel plate Ludwi Soret cell is greatly enhanced by arranging the h and cold plates to have a steady relative velocity in direction in their own planes. In a closed syste this causes a counterflow of gas between the plat In the example worked out here for separating t Cl isotopes, using HCl gas a yield of 100 g/dc of Cl^{37} at 80%, from the natural mixture (20%) obtained with a column 4 m. long. The colum might take the form of two coaxial cylinders or rotating inside the other (dia. 50 cm peripheral spe 20 cm/sec). The gas is contained in a spiral space, rectangular section, bounded by a spiral groove c in the surface of one cylinder (2 mm deep, 3 mm wid and by the smooth surface of the other cylinder.

R. H. DAVI

539.155

7059. The isotopic constitution of silicon, germaniun and hafnium. J. H. REYNOLDS. *Phys. Rev.*, 9 1047–9 (*June* 15, 1953).

The isotopic constitutions of silicon, germaniu and hafnium have been measured with a mass spectro meter by techniques which are described. Result for silicon are in good agreement with certain of th earlier determinations but are in poor agreement wit the values adopted in the recent compilation b Bainbridge and Nier (1950). Results for germaniu do not differ significantly from earlier determination Results for hafnium differ only slightly from the on previous determination in which electrical detectio was used, but in such a way as to suggest that dete minations on hafnium which has been fractionall

fied with respect to zirconium may not be faith-
y representative of the true abundances. An upper
t of 0·003% has been placed on the abundance
ature of Hf^{182}. A.

539.155.2 : 523.877

he abundances of the elements. *See Abstr.* 6437

539.155.2 : 535.343.4–15

0. An infrared isotope analyzer. J. C. KLUYVER
J. M. W. MILATZ. *Physica*, **19**, 401–11 (*May*,
3).

he shift in the infrared absorption bands of
opic molecules is used in a new method for deter-
ing the isotope ratios in tracer experiments [see
tr. 7754 (1952)]. The infrared absorption is
sured with a non-dispersive filter instrument
taining as selective detector a gas cell filled with a
centrated sample of the component to be
sured. An instrument is devised according to
method to measure the C^{13}/C^{12} ratio in carbon
xide. It permits the measurement of the C^{13}
ndance in 30 mg carbon dioxide with an error
0·005 at. % in the neighbourhood of the natural
ndance of 1·1 at. %. This precision is sufficient
the majority of tracer experiments. A.

539.155.2 : 539.163

1. Table of isotopes. J. M. HOLLANDER,
ERLMAN AND G. T. SEABORG. *Rev. mod. Phys.*,
469–651 (*April*, 1953).

he table represents a complete list of all the
ioactive and stable isotopes of the elements, to-
ier with a number of their salient features (e.g.
abundance; type, period and energy of decay;
hod of production and genetic relationships) as
orded by about December, 1952.

539.155.2 : 551.46

**pendence of O^{18}/O^{16} ratio in $CaCO_3$ on tempera-
of deposition, in fossil shells.** *See Abstr.* 7346

DIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08 : 539.163.1

**2. The design of an automatic recording electro-
e and its use to determine half-lives in radioactive
ay.** R. M. BARTHOLOMEW, F. BROWN, W. D.
WELL, W. R. J. SHOREY AND L. YAFFE. *Canad. J.
s.*, **31**, 714–22 (*July*, 1953).

n automatic recording electroscope has been
structed and used to determine short half-lives in
ioactive decay. The operation of the instrument
been tested by comparing it with both a manually
rated electroscope and a 4π-type proportional β-
nter. The instrument produces results which are
east as accurate as any with which they may be
pared. The half-lives of Co^{60m} and Al^{28} have
n measured as $10{\cdot}47 \pm {\cdot}02$ min and $2{\cdot}27 \pm$
min respectively. A.

539.163 : 539.155.1

**mass spectrographic determination of the decay
gies of Rh^{102} and Rh^{104}.** *See Abstr.* 7053

539.163 : 539.155.2

able of isotopes. *See Abstr.* 7061

539.163.08 : 537.542 : 621.318.572

7063. Contribution to the experimental study of nuclear isomerism; application of the method of delayed coincidences to research and to the study of metastable states of short period. R. BALLINI. *Ann. Phys.* [*Paris*] **8**, 441–89 (*May–June*, 1953) *In French.*

Describes in detail the construction of a 10-channel pulse interval analyser (channel width 1 μsec–1·12 msec in 7 steps) and its use in the study of short-lived radioactivities. A. O. STANESBY

539.163.1/.2

7064. ^{68}Cu, a new copper isotope with ½-life 32 sec. A. FLAMMERSFELD. Note in *Z. Naturforsch.*, **8a**, 274–5 (*April*, 1953) *In German.*

A new copper activity was obtained by irradiation of Zn and Ga with 1·4 MeV neutrons, and assigned to Cu^{68}; the ½-life is 32 ± 2 sec, and the radiation emitted negative β-particles with E_{max} 3·0 ± 0·2 MeV. A. O. STANESBY

539.163.1

7065. The half life of calcium 45. C. F. G. DELANEY AND J. H. J. POOLE. *Sci. Proc. Roy. Dublin Soc.*, **26**, 129–31 (*Feb.* 6, 1953).

The half-life of calcium 45 has been redetermined by following its decay with an end-window Geiger counter for over 200 days. The result is 163·5 days with a calculated maximum error of ±4 days. A.

539.163.1

7066. The half-life of Co^{60}. J. KASTNER AND G. N. WHYTE. *Phys. Rev.*, **91**, 332 (*July* 15, 1953).

A new determination of the half-life of Co^{60} yields the value 5·21 ± 0·04 years. A.

539.163.2

7067. The disintegration of Tm^{170}. R. L. GRAHAM, J. L. WOLFSON AND R. E. BELL. *Canad. J. Phys.*, **30**, 459–75 (*Sept.*, 1952).

The radiations from the decay of Tm^{170} (127 day) have been studied by means of a lens-type β-ray spectrometer, a scintillation spectrometer, short resolving time ($2\tau_0 = 2 \times 10^{-9}$ sec) coincidence counting techniques, and a pair of lens-type β-ray spectrometers placed end to end with coincidence counting of the focused radiations from a single source. A disintegration scheme is proposed which is consistent with the experimental results. Decay is found to be by negative β-ray emission; the spectrum consists of two components, one of maximum energy 968 ± 4 keV (76%) proceeding to the ground state of Yb^{170} and one of maximum energy 884 ± 4 keV (24%) to an excited state in Yb^{170} followed by emission of a γ-ray or conversion electron to the ground state. The γ-ray transition in Yb^{170} is found to have an energy of 84·1 ± 0·1 keV, a half-life of $(1{\cdot}57 \pm 0{\cdot}05) \times 10^{-9}$ sec, and conversion coefficients $\alpha_K = 1{\cdot}60 \pm 0{\cdot}15$, $\alpha_L = 4{\cdot}1 \pm 0{\cdot}5$, $\alpha_M = 1{\cdot}2 \pm 0{\cdot}2$ which show that it is electric quadrupole in character. Upper limits are given for decay by *K*-capture, 0·3%, or positive β-ray emission, 0·01%, and also for the occurrence of other γ-rays. A

539.163.2 : 539.172.13

7068. The new radioactive isotopes vanadium 46, manganese 50, cobalt 54. W. M. MARTIN AND S. W. BRECKON. *Canad. J. Phys.*, **30**, 643–57 (*Nov.*, 1952).

Three new positron activities assigned to V^{46}

(0·40 sec; $E_{max} > 6·0$ MeV), Mn^{50} (0·28 sec; $E_{max} > 6·3$ MeV), and Co^{54} (0·18 sec; $E_{max} > 7·4$ MeV) have been induced by (p, n) reactions which take place in the McGill cyclotron at thresholds less than 12·5 MeV. The assignments are based on the thresholds and on the approximate *ft* values of the transitions. After a brief period of bombardment, controlled through the oscillator, the targets are shot back by a pneumatic extractor to a position of minimum magnetic field near the cyclotron where a suitably shielded anthracene counter system sends pulses to the main laboratory. Finally, the output of a counting-rate meter is displayed against time on an oscilloscope. This visual display reveals immediately new periods in decays, which are then photographed for later analysis. A.

539.163.2

7069. Spectrometry using scintillations (with coincidence measurement for β and γ rays) and consecutive γ rays from radioactivity of Sc^{46}. S. Koicki, R. Ballini and R. Chaminade. *C.R. Acad. Sci.* [*Paris*] **236,** 1155–7 (*March* 16, 1953) *In French.*

A NaI–Tl scintillation counter is used to investigate the decay scheme of Sc^{46}. The energy level scheme of Nagi, Sen and Chatterjee [*Nature* [*London*] **164,** 1001 (1949)] appears to be invalidated by the experimental results. G. F. J. GARLICK

539.163.2

7070. Scintillation spectrometer study of the radiations from Zn^{65}. N. Perrin. Letter in *J. Phys. Radium,* **14,** 273–4 (*April,* 1953) *In French.*

The scintillation spectrum obtained from Zn^{65} is interpreted by comparison with spectra obtained from Na^{22}, Fe^{59} and Rb^{86}. Intensity ratios $\gamma(1·11 \text{ MeV})/\beta^+ = 31 \pm 5$ and $\gamma(200 \text{ keV})/\gamma(1·11 \text{ MeV}) \leqslant 10^{-3}$ are deduced. J. J. WILKINS

539.163.2

7071. On the radioactive decay of ^{112}Pd and ^{112}Ag. R. H. Nussbaum, A. H. Wapstra, N. F. Verster and H. Cerfontain. *Physica,* **19,** 385–90 (*May,* 1953).

The radioactive decay of $Pd^{112} \rightarrow Ag^{112} \rightarrow Cd^{112}$ has been investigated both with a β-γ coincidence apparatus and with a single channel NaI(Tl) scintillation spectrometer, the main features of which are described. In the Pd^{112} β^--decay, a γ-ray of about 18 keV was found. Coincidence absorption measurements with Ag^{112} yielded a complex β^--spectrum with a maximum energy of $4·1 \pm 0·3$ MeV ($\sim$25%), leading to the ground state of Cd^{112}, and at least two other components of $\sim 3·5$ MeV and $\sim 1·5$ MeV with roughly equal intensities. The main γ-transition in Ag^{112} has an energy of 620 ± 15 keV, while there is evidence for the presence of several more weak γ-lines in the energy ranges below 500 keV and between 1 and 2 MeV. A decay scheme and spin assignments for the levels which belong to the principal modes of decay are proposed. Redetermination of α_k of the 87 keV γ-ray in Pd^{109} yielded $9·2 \pm 1·5$. A.

539.163.2

7072. On the [level] scheme of $^{73}_{33}As$. R. Barloutaud and M. Sartory. *C.R. Acad. Sci.* [*Paris*] **236,** 1872–4 (*May* 11, 1953) *In French.*

The radiations from As^{73} were examined in a double proportional counter. The excited state (52 keV) of Ge^{73} has a short $\frac{1}{2}$-life ($\lesssim 5 \times 10^{-6}$ sec); ab... $0·6(\pm 0·06)$ of the *K*-capture transitions of As^{73} ... to the ground state of Ge^{73}. A. O. STANES...

539.16...

7073. Decay of Ga^{64} and Ga^{65}. B. Crasem... Letter in *Phys. Rev.,* **90,** 995–6 (*June* 1, 1953).

Ga^{64}, produced by the reactions $Zn^{64}(p, n)$, $Z...$ $(d, 2n)$ and $Cu^{63}(\alpha, 3n)$, decays by β^+-emission with... $\frac{1}{2}$-life of $2·6 \pm 0·1$ min. Ga^{65}, with a $\frac{1}{2}$-life of 15 m... emits 2 groups of positrons of max. energies 2·52... 0·05 (10%) and $2·1 \pm 0·1$ MeV (90%). A. O. STANES...

539.16...

7074. Formation and decay of Mo^{93m}. C. Forsthoff, R. H. Goeckermann and R. A. Na... mann. Letter in *Phys. Rev.,* **90,** 1004–5 (*June* 1, 195...

Mo^{93m} was produced by irradiation of Nb^{93} w... 4–18 MeV protons; the excitation curve is given. T... X-rays and internal conversion electrons emitt... during the decay of Mo^{93m} were examined; attem... were made to assign multipole orders and types ... transition involved: 262 keV γ-ray: *E*4; 684: *M*... and 1479: *E*2, or *M*1. A. O. STANES...

539.163...

7075. The decay of Cr^{49}. B. Crasemann a... H. T. Easterday. Letter in *Phys. Rev.,* **90,** 11... (*June* 15, 1953).

The positron spectrum was investigated with ... thick-lens spectrometer. Three components we... found with end points: $1·54 \pm 0·01$, $1·39 \pm 0·...$ and $0·73 \pm 0·05$ MeV with relative abundances 50... 35% and 15% respectively. Gamma-rays of 153 and 6... keV were observed from the photoelectrons ejecte... from a gold radiator. A decay scheme is suggeste... The half-life was found to be $41·7 \pm 0·5$ mi... J. HUGH...

539.163...

7076. Energy levels of C^{12} from the $Be^9(\alpha, n)C$... reaction. L. E. Beghian, H. H. Halban, T. Husa... and L. G. Sanders. Letter in *Phys. Rev.,* **90,** 11... (*June* 15, 1953).

A weak 3·16 MeV γ-ray was observed to follo... the reaction. This is probably emitted by a 0^+ lev... at $7·59 \pm 0·07$ MeV, which apparently de-excit... both by pair emission and by cascade γ-emissio... through the well-known level at $4·43 \pm 0·05$ MeV. J. M. CASSE...

539.163...

7077. The disintegration of Sr^{91} and Y^{91m}. D. ... Ames, M. E. Bunker, L. M. Langer and B. M... Sorenson. *Phys. Rev.,* **91,** 68–74 (*July* 1, 1953).

The radiations from the fission product Sr... (9·67 hr) and its daughter isomer Y^{91m} (50·3 mi... have been studied using a magnetic lens spectromete... a high resolution 180° focusing spectrometer and ... scintillation spectrometer. Coincidence measur... ments were made to check on certain genetic aspec... of the decay scheme. Five β-ray groups are observe... with endpoint energies and relative intensities ... 2·665 MeV, 26·4%; 2·03 MeV, 4·1%; 1·359 MeV... 29·2%; 1·093 MeV, 33·1%; and 0·62 MeV, 7·2%... The 2·665 MeV group has a shape characteristic of ... once-forbidden transition involving a spin change of ... units. Gamma-rays are found with energies of 1·41...

5, 0·93, 0·748, 0·645 and 0·5512 MeV. The min isomeric level in Y^{91} decays only by γ-emis- to the ground state. The 0·5512 MeV γ-ray ciated with this transition has a $K/(L+M)$ nal conversion ratio of 6·00, which is consistent an $M4$ assignment. A disintegration scheme is osed. A.

539.163.2

. **Gallium–64.** B. L. COHEN. *Phys. Rev.*, **91**, (*July* 1, 1953).

new isotope, 2·5 min Ga^{64}, was produced by the) reaction on Zn^{64} and identified by measurement he excitation function, by bombardment of rated isotopes, and by chemical separation. Its y scheme includes γ's of 0·97 MeV, 3·8 MeV probably 2·2 MeV. The maximum energy of the ciple β is about 5 MeV. The threshold for Zn^{64}) is $8·1^{+}\pm 0·5$ MeV. A.

539.163.2

. **Nuclear levels in Cs^{131}.** J. M. CORK, J. M. LANC, W. H. NESTER AND M. K. BRICE. *Phys.* , **91**, 76–7 (*July* 1, 1953).

sing enriched barium 130, activated in the pile, a trometric study has been made of the radiation n the resultant barium 131. Decaying by K-cap- with a half-life of 11·8 days, 13 γ-rays are found e associated with the disintegration, 8 of which not been previously reported. From the ive intensities of the electron lines and the photo- ron peaks, the multipolarities of 6 of the transi- s are given. A consistent nuclear level scheme of erms accounts completely for the observed ansitions. A.

539.163.2

). **The decay of Au^{197m}.** J. W. MIHELICH AND E-SHALIT. *Phys. Rev.*, **91**, 78–81 (*July* 1, 1953).

he conversion electron spectra of Hg^{197m} and ^{97m} have been re-examined. The 7·4 sec lifetime u^{197m} is found to be determined by a previously solved $E3$ transition of 130·2 keV energy, whose sition probability is 3×10^{-3} that expected on the sskopf estimate. The multipolarity of a "prompt" keV transition in Au^{197} is found to be $M1+E2$ ratio of magnetic to electric transitions being . A consistent decay scheme is presented. Some ematics of L sub-shell conversion are discussed. A.

539.163.2

. **Disintegration of Sb^{124}.** L. M. LANGER, H. LAZAR AND R. J. D. MOFFAT. *Phys. Rev.*, **91**, -41 (*July* 15, 1953).

he radioactive decay of Sb^{124} has been reinvesti- d in the large magnetic spectrometer and with tillation techniques. K and L photoelectron lines observed for γ-rays of energy 0·603, 0·641, 0·716, and 2·09 MeV. The curved Fermi plot of the est energy β-ray group is straightened by a once- idden correction factor consistent with a general β-interaction for spin change unity. Analysis in manner gives β-ray energies and intensities of 7 MeV, 21%; 1·602, 7%; 0·966, 9%; 0·61, 49% 0·24, 14%. The 0·603 MeV γ-ray is identified as ric quadrupole. A consistent decay scheme, tantiated by γ-γ and β-γ coincidences is proposed. A.

539.163.2

7082. The average number of neutrons emitted in the spontaneous fission of ^{242}Cm. F. R. BARCLAY AND W. J. WHITEHOUSE. *Proc. Phys. Soc.* [*London*] *A*, **66**, 447–53 (*May* 1, 1953).

The average number of neutrons ν emitted in the spontaneous fission of Cm^{242} was measured by a method depending on the device of counting only those neutrons which are detected after the occurrence of a fission. In this way the effect of neutrons from sources other than spontaneous fission is eliminated. The value found for ν is 3·0 neutrons per fission. The estimated standard error is 10–15%. A.

539.164 : 530.145.6

7083. On a new theory of alpha disintegration. K. C. KAR AND S. K. KUNDU. Letter in *Sci. and Cult.*, **18**, 549–50 (*May*, 1953).

A formula for the disintegration constant, based on the "classical" theory of Abstr. 6422 (1951) is stated. W. J. SWIATECKI

539.164.75

7084. Experimental relation between the range in air and the range in emulsions of α-particles of energy less than 5 MeV. G. HINSCHBERGER, A. STIRLING AND G. AMBROSINO. *C.R. Acad. Sci.* [*Paris*] **236**, 1870–2 (*May* 11, 1953) *In French.*

The α's from a thin Po deposit traverse a variable distance (R_0 cm) of air and their residual range (R microns) in emulsion is measured. For $15 < R < 22·4\,\mu$, $R_0 = 0·1879R - 0·358$, tending to $R_0 = 0·1879R$ for $5 < R_0 < 15\,\mu$. This enabled the conversion of emulsion ranges to energies for U II, U I, Th, Sm (4·77, 4·19, 4·01, 2·29 MeV respectively). W. J. SWIATECKI

539.165/.166

7085. Radiations from RaD and RaE. C. S. WU, F. BOEHM AND E. NAGEL. *Phys. Rev.*, **91**, 319–27 (*July* 15, 1953).

The electron and γ-spectra from RaD and RaE have been thoroughly investigated. The γ-radiation from RaD was studied with both krypton and argon proportional counters with brass and aluminium cathodes. The L_α, L_β and L_γ radiations of Bi were observed and identified with a critical absorber. The intensity ratios of $L_\alpha : L_\beta : L_\gamma$ are 1 : 1 : 0·2. The previously reported 7·8 keV (10%) line was not found but could be strongly excited by copper backing. The weak 23 keV line (10^{-3} per disintegration in these measurements) could be contributed from the piling effect of the detecting system. The conversion electrons of RaD were investigated in a solenoid magnetic spectrometer to obtain the L and $(M+N)$ conversion coefficients. The results are: $N_{eL}/N_\beta = 64\%$, $N_{eM+N}/N_\beta = 21\%$, $N_{eL+M+N}/N_\beta = (85\pm5)\%$. The conversion electrons of RaD were again investigated with a 180° β-spectrometer with a resolution of 0·8% and a counter window of $\sim 6\ \mu g/cm^2$. The $L_{\rm I}$, $L_{\rm II}$ and $L_{\rm III}$ conversion lines of the 46·5 keV γ-ray were resolved. The ratio of $L_{\rm I} : L_{\rm II} : L_{\rm III} : M_{\rm I-III}$: $M_{\rm IV-V} : N_{\rm I-V} : N_{\rm VI-VIII} + 0$ are 1 :0·075 :0·007 :0·25 : 0·006:007:0·007. From the ratios of the L-subshell conversion electrons, the 46·5 keV transition is interpreted as an $M1$ type. The upper limit of the intensity of the reported lines at 42 keV, at 37 keV and

at 31 keV must be less than 0·5% per disintegration if the same conversion coefficient is assumed. The unconverted 46·5 keV γ-radiation is 0·07 ± 0·02 per disintegration. Thus the excited state of 46·5 keV in RaE can account for (92 ± 5)% of the disintegrations. Neither internal conversion electrons nor nuclear γ-radiations are found in RaE. A faint X-ray (~ 80 keV) of the order of 10^{-4} per disintegration due to the ionization effect was observed in RaE. A brief discussion of the decay scheme of RaD and the possible spin assignments of various levels is included. A.

539.165

7086. Beta-spectrum of arsenic-71. H. Atterling and S. Thulin. Letter in *Nature* [*London*] **171,** 927 (*May* 23, 1953).

As^{71} was obtained by deuteron bombardment of Ge and subsequent isotope separation, and examined in an intermediate-image β-spectrometer. The positron spectrum has an upper limit of 815 ± 20 keV, with a weak component having an end-point at ~ 300 keV. Conversion lines indicating γ-rays of 23·3 ± 0·3 and 175 keV were observed. The ½-life was 65 ± 5 hr. A. O. STANESBY

539.165

7087. The beta-ray spectrum of ^{71}arsenic. P. H. Stoker and Ong Ping Hok. *Physica,* **19,** 279–86 (*March,* 1953).

The activity of As^{71}, obtained by bombarding Ge with deuterons of 26 and 14 MeV has been investigated. From the decay of the electron line of 163·9 keV the half-life was found to be 59·5 ± 2 hr. The 175 keV γ-ray gave the ratio $e_K/e_{L+M} = 8·3$. The Fermi–Kurie plot of the positron spectrum allowed two interpretations: a simple spectrum with endpoint at 800 keV or a complex one with endpoints at 675 and 850 keV. The two corresponding decay schemes are discussed. Four new electron lines were detected, which were ascribed to *L*- and *M*-conversion lines of a 13 keV γ-ray from As^{73}, and to *K–L*, *L* and *K–L*, *M* Auger lines. A.

539.165

7088. Measurements on the continuous beta-spectra, the conversion lines and the Auger-lines of $U(X_1 + X_2)$. P. H. Stoker, M. Heerschap and Ong Ping Hok. *Physica,* **19,** 433–44 (*May,* 1953).

Measurements on the β-spectra of $U(X_1 + X_2)$ in a 16·2 cm double-focusing spectrometer (resolution of 1·5%) are described. Of the electron lines 25 could be ascribed to 11 γ-rays, while the lines below 21 keV could be interpreted as *L* Auger lines on account of energy and intensity considerations. The Fermi–Kurie analysis of the continuous β-spectra gave 5 components with end-points at 2305, 1500 and 580 keV for UX_2 and at 193 and 103 keV for UX_1. The relative intensities were respectively 90%, 9% and 1% for UX_2 and 66% and 34% for UX_1. The 91 keV γ-ray of UX_1 is *E*2, while the 810 keV γ-ray of UX_2 may be *M*1. A tentative disintegration scheme with spin and parity assignments to some of the levels is discussed. A.

539.165

7089. Research on a double *K*-capture in zinc 64. A Berthelot, R. Chaminade, C. Levi and L. Papineau. *C.R. Acad. Sci.* [*Paris*] **236,** 1765 (*May* 4, 1953) *In French.*

No evidence of double *K*-capture was found in Zn^{64}; the half-life is estimated as $> 8 \times 10^{15}$ yr. A. O. STANE

539.

7090. An investigation of the β-particle spectrum mesothorium 2. J. Kyles, C. G. Campbell and W. Henderson. *Proc. Phys. Soc.* [*London*] *A,* **66,** 519 (*June,* 1953).

Using a permanent magnet double β-ray spectrometer, the β-particle spectrum of mesothorium 2 examined, and partial spectra with end points 2·18, 1·85, 1·70, 1·11, 0·64 and 0·45 MeV found. A list of conversion lines is given with analysis in terms of γ-rays. A level scheme is forward which is consistent with the β-β, β-γ and coincidence measurements made. The ground ground state transition is unobserved, the pa spectrum of highest energy corresponding to excited state at 57 keV which is metastable wit half-life greater than 10^{-2} sec.

539.

7091. The β-decay of Li^8. D. StP. Bunbu Letter in *Phys. Rev.,* **90,** 1121 (*June* 15, 1953).

The angular correlation of the decay electrons the α-particles emitted in the subsequent decay of Be^8 was measured. The distribution was of the fo $(1 + A\cos^2\theta)$, *A* having the values 0·20 ± 0·04 0·12 ± 0·09 for electrons of 9·8 and 7·5 M respectively. This result confirms the non-zero s of the 3 MeV level in Be^8, and rules out the possibi of the Li^8 β-decay being allowed. Measurements a placed an upper limit of 0·8 ± 0·3% on the num of disintegrations leading to the 4·9 MeV level in B J. HUG

539.165 : 537.533

Radioactive charging through a dielectric mediu *See Abstr.* 6848

539.165 : 539.1

7092. The influence of external fields on angu correlation. E. Heer. *Physica,* **18,** 1215–26 (*De* 1952).

A qualitative account of the theory and some expe ments on the decrease of anisotropy between succ sive nuclear radiations which can be produced external or atomic magnetic fields or the inhom genous electric fields in crystals. The results of application to the measurement of the mixing rati of *E*2 and *M*1 radiations from Cd^{111}, Cd^{114} and Pt are given. Experiments on Cd^{111} [see Abstr. 83 (1952)] are discussed in more detail. W. J. SWIATEC

539.165

7093. Interference terms of the electron-neutri angular correlation. M. Morita. Letter in *Phy Rev.,* **90,** 1005–6 (*June* 1, 1953).

The electron-neutrino angular correlation functio $\mathfrak{W}$ in the allowed and first-forbidden transitions the Fermi β-decay theory have been deduced, a the interference terms are given [for square ter see Greuling and Meeks, Abstr. 5723 (1951)]. A. O. STANES

539.165.2

. **Matrix elements of β-decay in *jj* coupling.** ALMI. *Phys. Rev.*, **91**, 122–5 (*July* 1, 1953).
atrix elements of various allowed β-transitions calculated in the *jj*-coupling scheme. It is found for Gamow–Teller matrix elements there is no nction between favoured and unfavoured transi-s, which appears to be in contrast with the experi-tal facts. A.

539.165.2

. Angular correlation in allowed β-transitions. E. ROSE. *Phys. Rev.*, **91**, 197 (*July* 1, 1953).
is shown how the effect of adopting conditions e expected in practical experiments (e.g. a wide d of β-energy is accepted) is to remove certain iguities in determining interaction coupling terms n measurements of correlation between β-ray and il nucleus.

539.166

5. The angular correlation of Ni^{60}. T. WIEDLING. *. Fys.*, **7**, *Paper* 6, 69–71 (1953).
cintillation counter measurements gave $\pi)/W(\pi/2\} - 1 = 0{\cdot}147 \pm 0{\cdot}007$, uncorrected for angular resolution of the counters. The resolution determined experimentally, and corrections were ulated from two available formulae, giving final ilts of 0·155 and 0·162 respectively (theoretically ected correlation = 0·167). J. J. WILKINS

539.166

7. Search for anomalous absorption of Ra(B + C) ays. W. R. DIXON AND G. N. WHYTE. *Canad. J. s.*; **30**, 438–41 (*Sept.*, 1952).
he absorption of Ra(B + C) γ-rays in lead from to 26 cm has been investigated in a search for the malies reported by Chaudhary [Abstr. 2920 (1948)]. such anomalies were found. A.

539.166

8. On the γ-ray spectrum of Ra(B + C). G. N. TYTE. *Canad. J. Phys.*, **30**, 442–9 (*Sept.*, 1952).
Measurements of the transmission of Ra(B + C) ays through lead between 0 and 26 cm are described l compared with the transmissions predicted on the is of a modified version of the γ-ray spectrum of s and Aston and on the basis of the spectrum of yshev *et al.* Ellis and Aston's spectrum gives the ter agreement. Both the relative and absolute ues of the γ-ray intensities given by Ellis and on are revised in the light of more recent informa-n. This revised spectrum leads to a predicted value 0·84 roentgens per hour at a metre for the γ-ray put of a gram of radium and its equilibrium ducts in 0·5 mm of platinum, in good agreement h experiment. A.

539.166

9. Nomogram of lifetime-energy-spin for gamma-transitions. R. MONTALBETTI. *Canad. J. Phys.*, 660–2 (*Nov.*, 1952).
A nomogram of the recent Weisskopf formula bstr. 9674 (1951)] relating the mean life for γ-ray nsitions to the energy and spin change has been nstructed. The nomogram is useful in that it ows rapid computations and shows at a glance the endence of mean lifetime upon the variables olved. A.

539.166

7100. Angular distribution and polarization of gamma radiation emitted by oriented nuclei. H. A. TOLHOEK AND J. A. M. COX. *Physica*, **19**, 101–19 (*Jan.–Feb.*, 1953).

These are calculated assuming pure multipole transitions. For the description of the orientation of the nuclei $2j$ independent parameters f_k are used; these are essentially the statistical tensors introduced by Fano (j is the spin quantum number of the nuclei). The state of polarization of the γ-radiation is characterized by the degree of polarization P and a real three-dimensional polarization vector ξ_0. If these quantities f_k, P and ξ_0 are used, the formulae take a relatively simple form. For the cases of dipole and quadrupole radiation expressions are given which are suitable for numerical calculation by easy substitutions. A.

539.166

7101. Scattering and absorption of gamma-rays. P. MAIGNAN. *Ann. Phys.* [*Paris*] **8**, 202–58 (*March–April*, 1953) *In French.*

A study of the scattering of γ-radiation from a monochromatic point source within a homogeneous absorbing medium is presented. The spectral distributions and total energies of the radially outgoing and backscattered fluxes are calculated, using methods similar to those of Hirschfelder *et al.* [Abstr. 2556 (1948)]. Numerical data are tabulated for distances up to 300 cm in water absorber, and source energies between 1·5 and 5·0 MeV. The applicability of the data to other absorbing media is discussed. Experiments with a RTh source in water absorber are reported, giving good general agreement with the calculations. The predicted values of outgoing energy flux, however, appear to be a few per cent too high. J. J. WILKINS

539.166

7102. Study of the γ-radiations emitted by ionium and radiothorium. G. BOUISSIÈRES, P. FALK-VAIRANT, M. RIOU, J. TEILLAC AND C. VICTOR. *C.R. Acad. Sci.* [*Paris*] **236**, 1874–6 (*May* 11, 1953) *In French.*

A NaI(Tl) scintillation counter was used, and the following γ-rays found: Io, 67 keV (relative intensity 100), 150 ± 3 (12·5), 200 ± 15 (?) (~1) and 254 ± 5 (3); RdTh, 84 (100), 133 ± 2 (14), 172 ± 4 (10) and 216 ± 3 (17). The absolute intensity of the 67 keV γ-ray of Io was $0{\cdot}33 \pm 0{\cdot}1$ photons per 100 disintegrations. A. O. STANESBY

539.166

7103. Effect of the electric quadrupole interaction on the γ-γ directional correlation in Cd^{111}. II. H. ALBERS-SCHÖNBERG, E. HEER, T. B. NOVEY AND R. RÜETSCHI. Letter in *Phys. Rev.*, **91**, 199 (*July* 1, 1953).

For Pt I, see Abstr. 5032 (1953). On melting a polycrystalline metallic indium source, the anisotropy has been observed to increase from 9·5% to 22%. The quadrupole interaction hypothesis is discussed in connection with this and other older experiments. J. J. WILKINS

539.166

7104. Gamma-ray spectrum of ionium (Th^{230}). F. RASETTI AND E. C. BOOTH. *Phys. Rev.*, **91**, 315–18 (*July* 15, 1953).

The γ-ray spectrum following the α-decay of

ionium (Th^{230}) was investigated using a scintillation spectrometer. The following γ-ray energies (in keV) and intensities (quanta per disintegration) were observed: 68(0·010); 142(0·0014); 255(0·0005). The 68 keV and 142 keV lines were found to be emitted in cascade; the third apparently represents a transition to the ground state. A level diagram for the product nucleus, Ra^{226}, is suggested. A.

539.166

7105. Gamma-radiation from arsenic 77. S. A. Reynolds, G. W. Leddicotte and H. A. Mahlman. *Phys. Rev.*, **91**, 333 (*July* 15, 1953).

Two previously unreported γ-rays have been observed in the decay of As^{77}. A.

539.166

7106. Neutron capture gamma-rays in cadmium, cobalt, and chlorine. W. A. Reardon, R. W. Krone and R. Stump. *Phys. Rev.*, **91**, 334–7 (*July* 15, 1953).

A two-crystal scintillation spectrometer has been used to measure the γ-ray spectra resulting from the thermal neutron capture in Cd^{113}, Co^{59} and Cl^{35}. Measurements extended over the range of energies from 0·6 MeV to 4·0 MeV. Several prominent γ-rays were observed. Intensity considerations suggest that cascades involving several of these low energy γ-rays play a dominant part in the decay schemes. A.

539.166

7107. Theory of the penetration of γ-rays through thin barriers. J. P. Vinti. *Phys. Rev.*, **91**, 345–8 (*July* 15, 1953).

A theoretical investigation is made of the penetration of monochromatic, parallel, unpolarized, normally incident γ-rays through barriers so thin that photons scattered more than twice can be neglected. The principal contribution of the paper is the derivation of a simple solution for the distribution function n_2 of the twice-scattered photons, capable of significant physical description and reasonably easy use for accurate computations. If the directions of travel of the incident photons and of a twice-scattered photon of wavelength λ are represented by points on a unit sphere and if M is the midpoint of the great-circle arc joining them, twice-scattered photons of the specified direction and wavelength are produced only by those once scattered photons whose directions of travel intersect the unit sphere in a certain parallel of latitude about the point M as pole. The function n_2 vanishes for all directions lying outside a certain allowed cone with axis along the incident direction, while for directions along the axis or along the surface of this cone it is given by a simple closed formula. For directions within the cone it is given by a quadrature over the above parallel of latitude, calculable by means of a Bronwin formula with a small number ω of terms, corresponding physically to the grouping of the contributing once scattered photons into 2ω equally spaced beams. Comparison with experiment is made by computing the expected counting rate in an experiment by Faust on the penetration of 1·25 MeV γ-rays from cobalt 60 through flat sheets of aluminium. Calculated values appear to be within the experimental error for thicknesses of one inch or less. A significant increase in the discrepancy at a thickness of two inches indicates that photons scatt more than twice begin then to be important.

539.16

7108. A simplified automatic isodose reco A. Cole, E. B. Moore and R. J. Shalek. *Nucleo* **11**, 46–8 (*April*, 1953).

The instrument described plots the surface equal dose about γ-ray sources. The source is f to the shaft of a recording turntable and doses measured by a small anthracene scintillation pr which can be driven radially to or from the so by means of an electric motor, the position of probe being marked by a stylus on the rotating ch The motor drives the probe to or away from source accordingly as the photomultiplier cur output falls below or rises above a given preset le As the source rotates, the stylus plots an isod contour. The equipment described has a maxim sensitivity of 3r/hour. L. R. SHEPH

539.166

7109. The determination of photon flux for ener between 150 and 200 MeV. P. D. Edwards a D. W. Kerst. *Rev. sci. Instrum.*, **24**, 490–5 (*Ju* 1953).

A calorimetric method of determining photon f is described. Absolute calibration was perform with an improved Pb block calorimeter using th mistors as temperature sensitive elements. Fi minute irradiations were employed with a maxim of 33 milliwatts emerging from a 0·5 in. collima placed at 115 cm from the betatron target. secondary standard was developed for the purpose determining bremsstrahlung flux. This seconda standard was a 4 in. dia., parallel plate ionizati chamber consisting of a 0·016 in. Al centre f separated by 0·052 in. air gaps from 0·25 in. Cu fro and back plates and adapted for use with a Victore M-70 electrometer. With corrections described, t results, in ergs/e.s.u. per cm air (NTP), are 7340 300 MeV, 6370 at 250 MeV, 5720 at 200 MeV a 5370 at 150 MeV. Calibration of Victoreen thimb with various types of convertor were also made.

539.166

7110. γ-coincidences in $_{84}Po^{214}$. F. Demicheli and R. Malvano. *R.C. Accad. Naz. Lincei*, **1** 259–61 (*Feb.*, 1953) *In Italian.*

Of the 5 possibilities suggested by Rutherfor Lewis and Bowden [Abstr. 4843 (1933)] only 3 we confirmed experimentally. These were: 0·933, 1·76 1·376, 0·760 and 1·120, 1·761 MeV. F. R. HO

539.166

7111. Indications of the interaction of electric fie gradients and nuclear electric quadrupole moments angular correlation [of γ-rays]. R. M. Steffe Letter in *Phys. Rev.*, **90**, 1119 (*June* 15, 1953).

539.166.7

7112. Initial distribution of Compton electron H. E. Johns, D. V. Cormack, S. A. Denesuk an G. F. Whitmore. *Canad. J. Phys.*, **30**, 556–64 (*Sep* 1952).

Modifications of the Klein–Nishina formula fo the Compton effect are presented which give th energy distribution and the angular distribution o the recoil electrons. Electron distributions have bee

ulated for photon energies from 10 keV to MeV. The distributions of the electrons produced Co^{60} γ-rays have been determined. A.

539.166.74

3. Resonant nuclear scattering of ^{198}Hg gamma-. P. B. MOON AND A. STORRUSTE. *Proc. Phys. [London] A*, **66**, 585–9 (*July*, 1953).

he resonant scattering has been measured using original principle of Doppler shift produced by hanical motion, but with a quite different experi- tal arrangement. The intrinsic width of the 11 MeV excited state is estimated to be about 10^{-6} eV, corresponding to a half-life of about 10^{-11} sec. The difference from the first estimate $\sim 10^{-11}$ sec) is mainly due to the statistical weight or of 5 resulting from the now well-established (2) of the excited state. This factor causes the nant-scattering values to differ considerably from most recent direct measurement of the half-life $0 \pm 1{\cdot}7) \times 10^{-11}$ sec, and possible causes of the repancy are discussed. A.

539.166.83

4. A determination of the multipole character of 637 and 722 keV γ-ray transitions in Xe^{131}. J. L. LFSON. Letter in *Canad. J. Phys.*, **30**, 715–16 *v.*, 1952).

tedetermination of the *K*-conversion coefficients firm that the 637 keV γ-ray is electric quadrupole str. 5277 (1952)] and not dipole [Abstr. 6742 52)] with possibly some admixture of magnetic ole. The 722 keV line is similar.

539.166.835

5. Polarization of the three-photon annihilation iation. L. LEIPUNER, R. SEIGEL AND S. BENEDETTI. Letter in *Phys. Rev.*, **91**, 198 (*July* 1, 3).

his has been observed, using a triple coincidence angement, by counting two of the photons directly d counting the third after Compton scattering. sults in agreement with theory were obtained.

J. J. WILKINS

539.167.3

6. Apparatus for large-scale production of sphorus-32. W. J. ARROL. *Nucleonics*, **11**, 26–8 *ay*, 1953).

he P^{32} is produced by pile irradiation of sulphur cks. Irradiation in the strongest flux in BEPO lds 1 mC per gram of sulphur. 1·8 kg of the adiated sulphur is heated at 125°c in a Pyrex ntainer inside a pressure vessel, with 1500 ml of N nitric acid. The phosphorus passes into solution orthophosphoric acid, about 70% going into ution after 3 hours heating. The solution is sequently evaporated to 80–100 ml and the sphorus precipitated with lanthanum hydroxide. is separated from cationic impurities including the thanum, in an ion exchange column and after nporation to dryness and destruction of traces of ganic matter by 100-volume H_2O_2, is made into a ution with double-distilled water. L. R. SHEPHERD

539.167.3 : 615.849

7. Production of multicurie gamma-ray tele- rapy sources. D. T. GREEN, R. F. ERRINGTON, F. C. BOYD AND N. J. HOPKINS. *Nucleonics*, **11**, 29–37 (*May*, 1953).

The requirements for γ-ray therapy sources are outlined. Irradiation problems, particularly the effect of neutron shielding in the target materials on the strength of pile-produced sources, are discussed. A table of isotopes suitable for multicurie γ-sources, with estimates of the relative pile irradiation costs of each, is compiled. It is concluded, that Co^{60} is the cheapest source suitable for deep therapy.

L. R. SHEPHERD

539.169

7118. Preliminary experiments using Mg^{28} as a tracer with chlorophylls, plants, and their extracts. R. S. BECKER AND R. K. SHELINE. Letter in *J. chem. Phys.*, **21**, 946–7 (*May*, 1953).

Experiments indicate little exchange of Mg^{2+} with pure chlorophyll *a* or *b*. A. O. STANESBY

539.169 : 537.564

The electric collection of radioactive ions of bromine, technetium and indium. *See Abstr.* 6900

NUCLEAR REACTIONS 539.17

539.17 : 523.877

Certain nuclear reactions of astrophysical importance. *See Abstr.* 6438

539.17 : 537.533

7119. A centrifugal pump target assembly for the cyclotron bombardment of liquids. W. M. GARRISON, H. R. HAYMOND, H. POWELL, C. CORUM AND J. G. HAMILTON. *Rev. sci. Instrum.*, **24**, 462–3 (*June*, 1953).

A detailed description is given of an apparatus for circulating liquids continuously during their bombardment by the external beam of a cyclotron. Temperature and rate of flow are controlled, and the beam enters the liquid through a thin foil window, all the rest of the equipment being made of Pyrex.

J. H. FREMLIN

539.172

7120. Observation of "jets" of large and small aperture in photographic emulsions. C. DILWORTH, S. GOLDSACK, T.-F. HOANG AND L. SCARSI. *C.R. Acad. Sci. [Paris]* **236**, 1551–3 (*April* 20, 1953) *In French.*

An examination has been made of the number of charged particles observed in "jets" recorded in nuclear emulsions, that is, in "showers" produced by a single nucleon-nucleon collision in which not more than two "shower" particles have an ionizing power greater than 1·5 times the minimum. The "showers" can be analysed into two groups: in one, large-aperture "showers," the number of secondary particles is proportional to the energy of the primary particle; and in the other, small-aperture "showers," the number of "shower" particles increases very slowly with the energy of the primary particle. The existence of these two groups may arise from different degrees of inelasticity of collision or they may be due to different types of primary particle. A. C. COATES

539.172

7121. The geometry of the angular distribution of nuclear reactions. O. HITTMAIR. *Acta phys. Austriaca.* **7**, *No.* 1, 102–9 (1953) *In German.*

The group theoretical side of a nuclear reaction (vector addition of angular momenta, rotational properties of operators) is separated from the physical part depending on the nuclear model and a general treatment given in terms of Racah coefficients. As illustration the angular distribution of inelastic *n* scattering by Pb^{204} is worked out. W. J. SWIATECKI

539.172

7122. Theory of polarized particles in nuclear reactions [of the form $a + X \rightarrow Y + b$]. A. SIMON. Letter in *Phys. Rev.*, **90**, 991 (*June* 1, 1953).

The formula for the spin tensor moments of *b* given in Abstr. 5054 (1953) is generalized to the case of an arbitrarily polarized initial beam.

W. J. SWIATECKI

539.172

7123. Differential and total cross-sections for inelastic scattering in the continuum theory. O. HITTMAIR. *Z. Phys.*, **134**, *No.* 4, 483–7 (1953) *In German.*

General formulae for the above are given. Certain remarks in Abstr. 417–18 (1953) on the effect of coincidences of the subsequent γ's are corrected. By integrating over angles before summing over *m*, the appearance of Racah coefficients in the total cross-sections is avoided. Inelastic *n* scattering on Cd^{111} is treated numerically for energies of 250, 330, 345, 420 keV. W. J. SWIATECKI

539.172 : 537.591.8

Nuclear reactors due to cosmic rays. *See Abstr.* 6926–8

539.172.11

7124. Determination of the excitation function of $_{12}Mg(\alpha, n)_{14}Si$ nuclear processes. J. NAGY. *Acta phys. Hungar.*, **3**, *No.* 1, 15–21 (1953).

A half-spherical Mg metal surface is bombarded with the α-rays of a Po preparation placed in the centre of the half sphere. The excitation curves of the resulting Mg(α, *n*)S nuclear processes are measured by the BCl_3-filled ionization chamber. By measuring the counting rate of the chamber it is also possible to obtain the absolute yield of the nuclear transformation. The neutron radiation is likely to be emitted by the Mg^{25} isotope. A.

539.172.11

7125. The cross section for the reaction $Al^{27}(\alpha, \alpha 2pn)Na^{24}$ from threshold to 380 MeV. M. LINDNER AND R. N. OSBORNE. *Phys. Rev.*, **91**, 342–4 (*July* 15, 1953).

The cross-section *v.* energy curve has been determined from threshold to 380 MeV. A.

539.172.13

7126. An investigation of (*d*, *p*) stripping reactions. III. Results for ^{28}Si and ^{32}S. J. R. HOLT AND T. N. MARSHAM. *Proc. Phys. Soc.* [*London*] *A*, **66**, 467–76 (*May*, 1953).

For Pts I and II, see Abstr. 3592–3 (1953). Angular distribution measurements were carried out on a number of proton groups emitted as a result of the bombardment by 8 MeV deuterons of targets of natural SiO_2 and sulphur. Using the theory of stripping process spins and parities have been assig to the resulting states of Si^{29} and S^{33}. Certain these states in both nuclei are thought to be produ by simple excitation of the odd neutron. One of low states in each case probably involves the excited state of the nuclear core. In the following the excitation energy of each state in MeV is gi together with the suggested shell model term or possible spin values and parity. Si^{29}: ground s $(2s_{1/2})$, 1·28$(1d_{3/2})$, 2·03$(1d_{5/2}^{-1}2s_{1/2}^{2})$, 3·07(5/2, 3/2 3·62$(1f_{7/2})$, 4·93$(2p_{3/2})$, 6·38$(2p_{1/2})$. S^{33}: gro state $(1d_{3/2})$, 0·85$(2s_{1/2}^{-1}1d_{j}^{2})$, 2·90$(1f_{7/2})$, 3·26$(2p$ 4·21(3/2, 1/2−), 4·89(3/2, 1/2−), 5·72$(2p$ 6·48(3/2, 1/2−).

539.17

7127. An investigation of (*d*, *p*) stripping reacti IV. Results for ^{40}Ca and ^{88}Sr. J. R. HOLT AND T MARSHAM. *Proc. Phys. Soc.* [*London*] *A*, **66**, 565 (*June*, 1953).

Angular distributions were measured of some of proton groups emitted from targets of natural calci and strontium under bombardment by 8 M deuterons. The theory of the stripping process been used to enable assignments of spin and pa to be made to the corresponding states of Ca^{41} Sr^{89}. The first and second excited states of Ca^{41} thought to be states of single-particle excitation of odd neutron. In the following list the excitat energies in MeV are accompanied by the shell mo term or the possible spin values and the parity brackets: Ca^{41}: ground state $(1f_{7/2})$, 1·90 $(2p$ 2·42 $(2p_{1/2})$, 3·96 (5/2, 3/2+), 4·76 (5/2, 3/2 5·72 (5/2, 3/2+). Sr^{89}: ground state (9/2, 7/2 1·07 (7/2, 5/2−). The *Q*-value of the transition the ground state of Sr^{89} is 4·18 ± 0·08 MeV, a this nucleus has excited states at 1·07 ± 0· 2·09 ± 0·08, 2·66 ± 0·08, 4·73 ± 0·1 and 5·46 0·08 MeV.

539.172

7128. Polarization effects in (*d*, *p*) and (*d*, *n*) reactio H. C. NEWNS. *Proc. Phys. Soc.* [*London*] *A*, 477–83 (*May*, 1953).

The particles emitted from (*d*, *p*) and (*d*, *n*) reactio are shown to be polarized in a plane perpendicu to the plane of scattering. The direction of polari tion is shown to be related to the spin changes involv in the reaction. An estimate of the magnitude of t polarization and the angle at which the maximu occurs is made. The effect of the polarization the angular correlation of the γ-rays emitted fro the product nucleus when measured in coinciden with the outgoing particle is discussed and a co parison made with the result of Satchelor and Spie

539.172.

7129. Relative cross-sections for the excitation isomeric and ground states by the (*p*, *n*) reactio F. BOEHM, P. MARMIER AND P. PREISWERK. *He phys. Acta*, **25**, *No.* 5, 599–604 (1952) *In German.*

Relative cross-sections σ^{*}/σ for the excitation excited and ground states were obtained for 14 nuclid from Sc^{44} to Hg^{197}, using monokinetic 6·7 Me protons. The results are discussed. A. O. STANES

539.172.13

Angular distribution of the gamma rays from eaction $N^{15}(p, \alpha\gamma)C^{12}$. C. A. BARNES, D. B. S AND G. C. NEILSON. Letter in *Canad. J. Phys.*, 17–18 (*Nov.*, 1952).

signments of spin and parity are made to the excited states involved in this reaction, on the of new experimental observations.

539.172.13

Reaction energy of $O^{18}(p, \alpha)N^{15}$ and the ic mass of oxygen 18. C. MILEIKOWSKY. *Ark.* 7, *Paper* 8, 89–108 (1953).

e measurements, which are fully described, were by magnetic analysis of the primary and dary particles. The result was $Q = 3{\cdot}961 \pm$ MeV, and this gives the O^{18} mass as 04848 ± 0·000022 a.m.u. Agreement with other nuclear reaction data is good. J. M. CASSELS

539.172.13

. The calculation of the half-widths of one-body iances. J. L. JOHNSON AND J. L. MCHALE. *Rev.*, **91**, 87–9 (*July* 1, 1953).

alf-widths of resonances for protons incident on mber of light nuclei with Z ranging between 4 and e calculated in the one-body approximation. It und that neglecting the tail of the wave function e integral representing the probability of the on being in the incident state can lead to errors e order of 50%. Estimates of level shifts are made using formula derived by Breit. These esent approximately the difference between the gy at which the phase shift is 90° and the energies esponding to maxima of the absolute value of the l function $\mathfrak{F}$ or else of the absolute value of where G is the irregular function. Both $\mathfrak{F}$ and e normalized to unit amplitude at a large distance. A.

539.172.13

. Note on the polarization of the protons and ons arising from the D-D reaction. M. FIERZ. *phys. Acta*, **25**, *No.* 6, 629–30 (1952) *In German.* e theoretical conclusions obtainable from surements are discussed, in particular whether existence of singlet-triplet transitions can be ced from the relation of polarization to deuteron gy. F. R. HOLT

539.172.13

. Reaction energy of $Ne^{20}(d, \alpha)F^{18}$ by magnetic ysis. C. MILEIKOWSKY. *Ark. Fys.*, **7**, *Paper* 10, 19 (1953).

e result was $Q = 2{\cdot}791 \pm 0{\cdot}009$ MeV. This e gives a good energy balance in a certain light ear reaction cycle. J. M. CASSELS

539.172.13

. Comparison of D–T and D–^{3}He at low energies. G. JARVIS AND D. ROAF. *Proc. Roy. Soc. A*, **218**, 8 (*July*, 1953).

thin gas target was used to measure the absolute s-section and angular distribution of α-particles the two "mirror" reactions D–H^3 and D–He^3 deuteron energies below 45 keV. The reactions found to be isotropic and the variations of the cross-sections over the energy range 20 to eV can be expressed by the simple Gamow theory of penetration of the Coulomb barrier. The simple theory assuming the same energy-independent nuclear parameters for the mirror nuclei H^3 and He^3 was unable to account for the observed cross-sections of these two reactions. A.

539.172.3

7136. Photofission in B^{10} and B^{11} with γ-rays up to 31 MeV. P. ERDÖS, P. SCHERRER AND P. STOLL. *Helv. phys. Acta*, **26**, *No.* 3–4, 207–40 (1953) *In German.*

Photographic plates, loaded with boron, were exposed to γ-rays up to 31 MeV. Events corresponding to the following reactions were observed and their cross-sections determined: (1) $B^{11}(\gamma, t)Be^8$. (2) $B^{11}(\gamma, \alpha)Li^7$. (3) $B^{10}(\gamma, d)Be^8$. (4) $B^{10}(\gamma, \alpha)Li^6$. (5) $B^{10}(\gamma, np)2He^4$. The mechanisms of these reactions are thoroughly discussed. Three new energy levels of the Be^8 nucleus have been found (all these levels have even angular momentum and even parity): 2·2; 3·4; 6·8 MeV. All these levels of the Be^8 nucleus can be explained by a modification of the alpha model, proposed by Inglis. The simple decay scheme of the (γ, α) reaction on B^{10} permits conclusions on the character of absorption of the γ-radiation, respecting the selection rules. A.

539.172.3

7137. The photoneutron cross sections for the reactions $Br^{81}(\gamma, n)Br^{80}$ and $Br^{81}(\gamma, n)Br^{80*}$ and an analysis of the ratio between these cross sections. L. KATZ, L. PEASE AND H. MOODY. *Canad. J. Phys.*, **30**, 476–87 (*Sept.*, 1952).

Cross-section curves have been measured as a function of energy for the reactions $Br^{81}(\gamma, n)Br^{80}$ and $Br^{81}(\gamma, n)Br^{80*}$ and the ratio between these cross-sections has been examined critically. The curves exhibit the peaked shape characteristic of photonuclear reactions with maximum cross-sections of 88 and 42 millibarns respectively. It is shown that the ratio of the cross-sections depends on the spins of the excited levels in which the Br^{80} nucleus is left prior to γ cascading and thus on the reaction leading to it. An elementary analysis based on this point of view gives results consistent with the ratio measured for six different types of reactions. A.

539.172.3

7138. The photoneutron cross sections of Rb^{87}, Zr^{90}, and Mo^{92}. L. KATZ, R. G. BAKER AND R. MONTALBETTI. *Canad. J. Phys.*, **31**, 250–61 (*Feb.*, 1953).

The photoneutron cross-sections of the 50-neutron isotopes Rb^{87}, Zr^{90} and Mo^{92} have been measured as a function of photon energy. These cross-sections exhibit the peaked shape characteristic of photonuclear reactions. Peak values of 0·23, 0·27 and 0·14 barn at 17·5, 18·0 and 18·7 MeV respectively were found for these nuclei. The widths of all the curves at half maximum were about 6 MeV. In the case of zirconium and molybdenum the cross-sections to the isomeric and ground states of the residual nuclei have been determined separately. The ratio of the cross-sections, $\sigma_{\text{ground}}/\sigma_{\text{isomeric}}$, has been examined as a function of photon energy and is discussed in the light of the elementary analysis previously presented [preceding abstract]. A.

539.172.3

7139. Delayed photoneutrons in a heavy-water reactor. A. LUNDBY. *Nucleonics*, **11**, 16–17 (*April*, 1953).

The effect on reactor kinetics of the photoneutrons emitted from the heavy water moderator, due to the action of fission-product γ-rays, is investigated. 12·8 day La^{140} is one of the main sources of the effective γ-radiation. It was found, that, in the Kjeller reactor 2 days after shutdown from running at 200 kW for several weeks, the rate of emission of photoneutrons was equal to the neutron production in a reactor operating at a power level of 0·04 watts. It is shown, that a sudden increase of reactivity applied to the reactor produces a greater initial fast transient rise in power level in the presence of photoneutrons.

L. R. SHEPHERD

539.172.3

7140. The absolute standardization of the 2·615 MeV γ-rays of ThC″ and the cross section for the photodisintegration of the deuteron at this energy. P. MARIN, G. R. BISHOP AND H. HALBAN. *Proc. Phys. Soc.* [*London*] *A*, **66**, 608–16 (*July*, 1953).

The absolute number of short- and long-range α-particles from a source of active deposit of RdTh (0·6 mC) has been determined by counting, with an ionization chamber, in low geometry. This measurement gives a new value for the branching ratio $(0{\cdot}354 \pm 0{\cdot}004)$ and at the same time the absolute number of 2·615 MeV γ-rays emitted by this source $(0{\cdot}384 \pm 0{\cdot}009$ mC/mg radium equivalent of active deposit). The same source has then been compared with a standard radium source on a Curie-type ionization chamber. The procedure for future absolute calibration is in this way simplified. The increased precision of these measurements leads to a revision of former determinations of the cross-section for the photodisintegration of the deuteron at 2·615 MeV. This new cross-section is $(13{\cdot}80 \pm 0{\cdot}38)10^{-28}$ cm^2.

A.

539.172.3

7141. Analysis of photonuclear reactions. R. WILSON. *Proc. Phys. Soc.* [*London*] *A*, **66**, 645–8 (*July*, 1953).

A method is described which enables photonuclear cross-section curves to be derived from the appropriate yield curve with little ambiguity about assigning of errors.

A.

539.172.3

7142. Photo-alpha reactions in nuclear emulsions. C. H. MILLAR AND A. G. W. CAMERON. *Canad. J. Phys.*, **31**, 723–57 (*July*, 1953).

In experiments to search for new photonuclear reactions involving the emission of heavy particles ($Z \geqslant 2$), Ilford E1 emulsions were exposed to 240 roentgens of X radiation from the University of Saskatchewan betatron operating at energies up to 27 MeV. The plates were developed by a special "grain-gradation" technique which suppressed proton tracks and X-ray fog. The ejection of single α-particles was observed from C^{13}, N^{14}, O^{16}, Ag and Br. Multiple-pronged stars were observed due to the photodisintegration of Cu^{12}, N^{14}, O^{16} and probably Ag or Br. Interpretations of these events were deduced, cross-section versus energy curves for many of were obtained. Range-energy relationships obtained for Be^9, B^{10} and C^{12} particles in E1 emuls

539.1

7143. The $O^{16}(\gamma, n)O^{15}$ and $O^{18}(\gamma, p)N^{17}$ react R. MONTALBETTI AND L. KATZ. *Canad. J. Phys.* 798–803 (*July*, 1953).

The cross-section for the $O^{16}(\gamma, n)O^{15}$ reaction been determined by detecting the emitted neutr and the cross-section for the $O^{18}(\gamma, p)N^{17}$ reac has been determined by detecting the delayed neut following the decay of the N^{17} nucleus. Both c sections exhibit a slowly rising portion for s 3 MeV above threshold, followed by the usual l resonance shaped curve. This anomalous behav is discussed in the light of present photonuc theories.

539.1

7144. Photoprotons from Mo^{100} and Mo^{92}. W BUTLER AND G. M. ALMY. *Phys. Rev.*, **91**, 5 (*July* 1, 1953).

The absolute yield and the energy and ang distributions of protons emitted from targets of centrated isotopes Mo^{92} and Mo^{100}, under betra X-ray radiation of maximum energy 22·5 MeV, l been determined with nuclear emulsions as dete of protons. For Mo^{22} the proton is less tightly bo than the neutron by 5·0 MeV; for Mo^{100} the pr is more tightly bound by 2·4 MeV. Comparison the large yield and the energy distribution of pro from Mo^{92} with those calculated from the statis model shows good agreement except for an obse excess of high energy protons, which are also an tropic. They are presumably due to a direct emis process with which neutron emission does not com in the normal way. With Mo^{100}, however, the yi though 20 times smaller, exceeds the yield predi on the statistical model by 20 to 125 times depen upon the processes and parameters assumed in calculation. Most of the protons, therefore, m come from a direct process. The observed ene distribution is similar to one computed using experimental (γ, p) cross-section if it is assu that the residual nucleus is left with a typ exponential energy level density distribution. angular distribution is strongly anisotropic wit maximum near 45°, for protons of energy gre than 5 MeV.

539.17

7145. Nuclear photostar production. I. REFF. *Ph Rev.*, **91**, 150–5 (*July* 1, 1953).

Cross-sections for photonuclear star product are computed phenomenologically for photome production in a nucleus followed by meson absorpt in the same nucleus. Results are found for values the mean free path of mesons in nuclear matter 4×10^{-13} cm and 8×10^{-13} cm as a function of ato mass number and photon energy. The proc accounts for a large part of observed photostars w three and more prongs for elements as heavy as but for only a small part for elements as light as O.

539.172.3

. Consequences of charge independence for ear reactions involving photons. M. GELL-MANN V. L. TELEGDI. *Phys. Rev.*, **91**, 169–74 (*July* 1,).

me effects of the charge independence of nuclear es on the emission and absorption of photons by nuclei are investigated. It is found that the tion rules governing the change of isotopic spin T uch transitions are of practical importance in ei with $T_z = 0$ particularly the rule that $E1$ sitions without change of isotopic spin are for- en. Two examples of forbidden $E1$-emission (in and O^{16}) are discussed, and detailed experimental vestigation is suggested in connection with each hem. The main consequence for photonuclear tions of the aforementioned selection rule is that each $T_z = 0$ nucleus there is a threshold for wed) $E1$ absorption, corresponding to the first with $J = 1^-$, $T = 1$. For (γ, α)- and (γ, d)- tions, where no isotopic spin can be carried off he particle, $E1$ absorption can become effective when there is enough energy to leave the residual eus in a $T = 1$ state. The roles of $E2$ and $M1$ orption, with and without change of isotopic spin, discussed, and appropriate sum rules are derived. rules governing (γ, α) processes are applied icularly to reactions in C^{12} and O^{16}, where con- rable experimental evidence is available and ears to support the theoretical conclusions. A.

539.172.3

7. Photodisintegration processes in light even- nuclei yielding alpha-particles. D. L. LIVESEY AND . SMITH. *Proc. Phys. Soc.* [*London*] *A*, **66**, 689–99 *g.*, 1953).

he photodisintegration processes splitting the lei $_6C^{12}$ and $_8O^{16}$ completely into α-particles have n studied in some detail by the photographic e method. It is found that, for energies below ut 25 MeV resonances occur in the excitation tions, indicating that a compound nucleus inter- ation may be valid. These results, and also ain data of Green and Gibson concerning the astic scattering of neutrons in carbon, are related xcited states of the nuclei $_6C^{12}$ and $_4Be^8$ as inter- liate stages in the various processes. Levels in at 9·6 MeV and 11·3 ± 0·3 MeV occur and these d first an α-particle and $_4Be^8$ in the ground state, le a third level in $_6C^{12}$ near 12 MeV is found ield $_4Be^8$ in the broad 3 MeV excited state. Other ls in $_4Be^8$ at 4·1 MeV and 17 MeV, disintegrating two α-particles, are found as intermediate stages hese reactions. A.

539.172.4

8. The influence of nucleonic orbits on the ctive cross-section for capture of slow neutrons, the composition of the spin of odd-odd nuclei. . VAĬSMAN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 3, –4 (1953) *In Russian.*

he positions of high values in a list of some 69 ss-sections are pointed out. A rule is formulated ereby for odd-odd nuclei the spin is either the sum the difference of the spins of the separate N and roups. W. J. SWIATECKI

539.172.4

7149. Neutron cross sections in the MeV region. M. D. GOLDBERG. *Nucleonics*, **11**, 42–5 (*May*, 1953).

A summary of papers given at a recent conference held at Brookhaven National Laboratory, dealing mainly with the theory and measurement of total and inelastic scattering cross-sections in the MeV region. L. R. SHEPHERD

539.172.4

7150. Neutron capture cross section of Em^{222}. A. P. BAERG. Letter in *Phys. Rev.*, **90**, 1121 (*June* 15, 1953).

A value of 0·72 barns was obtained. The product actually observed and estimated was the α-active Ra^{223} formed by neutron capture and two successive short-period β-decays. J. M. CASSELS

539.172.4

7151. The parameters for the slow neutron resonance in rhodium. V. L. SAILOR. *Phys. Rev.*, **91**, 53–7 (*July* 1, 1953).

Measurements of the 1·26 eV resonance in rhodium have been made with a crystal spectrometer and the following values were obtained for the parameters: $E_0 = 1{\cdot}260 \pm 0{\cdot}004$ eV, $\sigma_0 = (5000 \pm 200) \times 10^{-24}$ cm^2, $\Gamma = 0{\cdot}156 \pm 0{\cdot}005$ eV, $g\Gamma_n = (3{\cdot}8 \pm 0{\cdot}2) \times 10^{-4}$ eV, and $\sigma_{fa} = (5{\cdot}5 \pm 1{\cdot}0) \times 10^{-24}$ cm^2. The shape of the resonance agrees to very high accuracy with the one-level Breit–Wigner formula. The procedure is discussed for analysing experimental data in cases where small corrections are required for instrument resolution and Doppler broadening. A.

539.172.4

7152. Total neutron cross sections of chlorine and carbon. R. M. KIEHN, C. GOODMAN AND K. F. HANSEN. *Phys. Rev.*, **91**, 66–7 (*July* 1, 1953).

Using CCl_4 in good geometry, $Li^7(p, n)$ neutrons and a pressurized hydrogen counter, σ_t(Cl) has been measured by the transmission method from 0·4 to 1 MeV at 30 keV intervals and from 0·15 to 0·75 MeV at 2 keV intervals. A.

539.172.4

7153. The pile neutron absorption cross sections of bismuth. D. J. LITTLER AND E. E. LOCKETT. *Proc. Phys. Soc.* [*London*] *A*, **66**, 700–4 (*Aug.*, 1953).

The pile neutron absorption cross-section of bismuth has been measured as 30·8 ± 2·2 millibarns. Also the activation cross-section of bismuth for the production of Po^{210} has been measured as 20·5 ± 1·1 millibarns. The difference between these two values, namely 10·3 ± 2·5 millibarns, is claimed to be the activation cross-section for the production of a long-lived α-particle emitting state of Bi^{210}. A.

539.172.4

7154. A method of calculating critical size in multi-group neutron transport theory for some simple systems. E. R. WOODCOCK. *Proc. Phys. Soc.* [*London*] *A*, **66**, 705–9 (*Aug.*, 1953).

A simple method is developed for obtaining a good approximation to the critical size of some simple nuclear reactors when neutrons of all relevant energies are allowed for by dividing them into a number of energy groups. The method is applicable for any number of energy groups. A.

539.172.4

7155. The elastic scattering of neutrons by tritons and of protons by ^{3}He. P. SWAN. *Proc. Phys. Soc.* [*London*] *A*, **66**, 740–52 (*Aug.*, 1953).

The theory of Abstr. 3606 (1953) which applied to an energy of 14 MeV is here extended to cover a number of neutron energies between 2·5 and 14 MeV. The scattering phases are evaluated using the variational methods of Hulthén and Kohn. The corresponding angular distributions for proton–He^3 scattering are obtained by treating the Coulomb field as a perturbation on the neutron–triton scattering, as both cases have the same symmetry properties. A.

539.172.4

7156. Fast fission factor for hollow natural uranium cylinders. R. L. MURRAY AND A. C. MENIUS. *Nucleonics*, **11**, 21–3 (*April*, 1953).

The probability that a fission neutron, released in a hollow or solid U cylinder, will produce an additional neutron due to fast fission in U^{238}, is calculated using the method of Guggenheim and Pryce [Abstr. 4374 (1953)]. Results are tabulated for cylinders of external radii of 1, 2, 3 and 4 cm and internal radii 0, 0·2, 0·4, 0·6 and 0·8 times the external radius. L. R. SHEPHERD

539.172.4

7157. The expansion of a fissionable gas as a source of atomic power. E. H. KERNER. Letter in *J. appl. Phys.*, **24**, 815–16 (*June*, 1953).

A fissile gas ($U^{235}F_6$) is assumed to be confined in a cylinder behind a reciprocating piston. The gas is alternately compressed to supercriticality and expanded to the subcritical state thereby doing mechanical work. A differential equation for the motion of the piston is derived and is solved for a particular example. It is shown that the amount of heat released per cycle is not impossibly sensitive to the amplitude of stroke and velocity of the piston. Only prompt neutrons are taken into account in the calculations. L. R. SHEPHERD

539.172.4

7158. Low-power thermal test reactor for nuclear physics research. H. B. STEWART, F. G. LAVIOLETTE, C. L. MCCLELLAND, G. B. GAVIN AND T. M. SNYDER. *Nucleonics*, **11**, 38–41 (*May*, 1953).

The reactor employs 20 cylindrical fuel slugs, 2 in. dia. × 24 in. long, each containing evenly spaced thin disks of an alloy of Al with enriched U (90% U^{235}), immersed in a light paraffin base oil which acts as a moderator. The fuel slugs are arranged in an annular array and are surrounded by a graphite reflector. The space inside the annulus is occupied by an internal thermal column containing a narrow slot to take danger coefficient samples, the thermal neutron flux in the sample position being $3{\cdot}4 \times 10^7$ n/cm²/sec/watt. Control is exercised by means of cadmium absorbers. The large expansion coefficient of the oil-moderator results in a large negative temperature coefficient of reactivity. A reactivity change of 5×10^{-7}, corresponding to a macroscopic absorption cross-section of 10^{-3} cm² is detectable in danger coefficient measurements. L. R. SHEPHERD

539.172.4

7159. Calculations on neutron flux distribution in the JEEP. M. BOGAARDT. *JENER Rep., No* 14 *pp.* (1951).

An essentially one-group theory is develo based on the concept of "neutron-resistance." flux distribution is derived, as a function of power level, both for the complete reactor and f reduced heavy-water level. In the latter case, comp sons are made with experimental data. J. J. WILL

539.1

7160. Measurements of neutron and gamma ra tion around the JEEP. M. BOGAARDT AND N. H *JENER Rep., No.* 2, 2 *pp.* (1951).

Measurements have been made with BF_3 coun and an ionization chamber. The interpretation the measurements is discussed and the results recorded. J. J. WILK

539.17

7161. Report on calculations of the neutron distribution in the reactor tank, the reflectors and thermal column of the uranium pile at Kjeller. N. H AND H. KLEPP. *JENER Rep., No.* 3, 18 *pp.* (1951)

The dimensions of the heavy-water pile are giv The calculations, by one group neutron theory, described in detail. J. M. CASS

539.17

7162. The reactivity of the JEEP as a function control plate position. M. BOGAARDT. *JENER R No.* 5, 3 *pp.* (1952).

The results of measurements of the doubling ti of the Kjeller heavy-water reactor as a function control plate position are given. L. R. SHEPHE

539.17

7163. Report on the first running-up of the nucl reactor at Kjeller, using two auxiliary BF_3-counters connection with a 100 mC Ra–Be neutron sour N. HOLT, H. KLEEP AND K. STEENBERG. *JENER Re No.* 7, 4 *pp.* (1951).

The procedure adopted in bringing the reactor criticality for the first time is outlined. L. R. SHEPHE

539.172

7164. Some remarks on the influence of the e pansion of heavy water on the reactivity of a nucle reactor. M. BOGAARDT. *JENER Rep., No.* 9, 5 *p* (1952).

It is shown that there is an almost linear relatio ship between reactivity and temperature over a limit range, assuming that all absorption cross-sectio follow the $1/V$ law, neutron temperature is propo tional to moderator temperature and thermal expa sion of all the reactor materials is neglected. If t thermal expansion of the D_2O moderator is taken int account, however, an increasing rate of loss reactivity with rising temperature results, in agre ment with experimental results on the French heav water pile. L. R. SHEPHER

ATOM AND MOLECULE BEAMS . MESON NEUTRONS 539.18

539.1

7165. On the production of mesons in the passag [of photons] through matter. A. FLORIAN. *Acta phys Austriaca*, **7**, *No.* 1, 23–51 (1953) *In German.*

Supplementing an earlier calculation [Abstr. 166

8)] the cross-section for the production of vector ons is derived, taking into account two additional mediate states arising from the presence of anti- ons. Numerical results for total cross-sections in imit of small photon energies. W. J. SWIATECKI

539.18

. The knock-on electrons produced by mesons ad. E. VAN A. GEY VAN PITTIUS AND I. J. VAN RDEN. *Physica*, **19**, 1–8 (*Jan.–Feb.*, 1953).

n experiment to determine the relation between relative number of knock-on electrons excited in layers by the penetrating component of cosmic ation and the thickness of the Pb layer, is ribed. To ensure that only those penetrating icles above a certain limit in the energy spectrum xplored, the total Pb thickness for a whole series adings was kept constant. An explanation of the es that were obtained is also given. A.

539.18

7. Differential cross sections for the scattering of Mev π^+ mesons in hydrogen. D. BODANSKY, SACHS AND J. STEINBERGER. Letter in *Phys. Rev.*, 996–7 (*June* 1, 1953).

his was determined for $30° < \theta_{lab} < 150°$ using nter techniques similar to those of Anderson *l.* (1952). See also abstract following.

W. J. SWIATECKI

539.18

8. Phase shift analysis of the scattering of tive mesons at 58 MeV. D. BODANSKY, A. M. HS AND J. STEINBERGER. Letter in *Phys. Rev.*, **90**, –8 (*June* 1, 1953).

ssuming only *s* and *p* scattering a fit with experi- t is possible (preceding abstract). A closer istical analysis with Coulomb effect included urs repulsive *s* and attractive *p* interaction.

W. J. SWIATECKI

539.18

9. Fermi's theory of nucleon collisions and the o-point energy of pions. F. C. AULUCK AND D. S. THARI. Letter in *Phys. Rev.*, **90**, 1002–3 (*June* 1, 3).

ecause of the Lorentz contraction of the collision me the zero-point energy becomes comparable n the collision energy. The probability for the ssion of *n* mesons is derived and shown to become rgy-independent for high *E*. W. J. SWIATECKI

539.18

0. Pion production ratios by proton bombard- nt. R. SAGANE. Letter in *Phys. Rev.*, **90**, 1003 ne 1, 1953).

atios of π^+ to π^- produced on Pb, Ag, Cu, Al, Be at 90°, and obtained with a 2π-angular focusing al orbit spectrometer at 13 ± 3, 18 ± 3, ± 2 MeV decrease with mass number and increase n energy. The total 42 MeV π^+ cross-section is $^{2/3}$. W. J. SWIATECKI

539.18

1. Observation of V^0 particles produced at the notron. W. B. FOWLER, R. P. SHUTT, A. M. ORNDIKE AND W. L. WHITTEMORE. Letter in *s. Rev.*, **90**, 1126 (*June* 15, 1953).

everal *V* tracks were found in a diffusion cloud mber traversed by neutrons produced in C targets exposed to the 2·2 BeV beam of 10^8–10^9 protons per pulse. Two examples are analysed and found to indicate a V_1^0 rather than V_2^0. W. J. SWIATECKI

539.18

7172. An unusual example of V^0 decay. R. W. THOMPSON, A. V. BUSKIRK, L. R. ETTER, C. J. KARZMARK AND R. H. REDIKER. Letter in *Phys. Rev.*, **90**, 1122 (*June* 15, 1953).

Discussion of a V^0 event in a cloud chamber showing a pos., 43 cm, $0·67 \pm 0·02$ BeV/c, min. ionization track at $79·2° \pm 0·4°$ to a neg. $0·094 \pm 0·008$ BeV/c track of 2–3 times min. ionization.

W. J. SWIATECKI

539.18

7173. *K* mesons. J. CRUSSARD, L. LEPRINCE-RINGUET, D. MORELLET, A. ORKIN-LECOURTOIS AND J. TREMBLEY. Letter in *Phys. Rev.*, **90**, 1127 (*June* 15, 1953).

Scattering, range and ionization measurements on 6 new *K* mesons (ranges up to 9000 μ) yield a mass $940 \pm 40\ m_e$, consistent with previous data. The upper limit of the energy spectrum of the secondary (a μ-meson?) is $p\beta c = 200$ MeV. W. J. SWIATECKI

539.18

7174. Unusual π–μ decays in photographic emulsions. W. F. FRY. *Phys. Rev.*, **91**, 130–4 (*July* 1, 1953).

A total of 11 841 π-μ decays has been studied in Ilford C-2 and G-5 photographic plates, where both the π- and μ-meson tracks stopped in the emulsion. In 12 cases the range of the μ-meson track from the π-meson decay is less than 480 microns and in 2 cases the range is greater than 720 microns. The ranges of the μ-meson tracks of the 14 unusual π-μ decays are: 120, 185, 258, 260, 290, 416, 430, 441, 444, 470, 470, 476, 828 and 1035 microns. The normal range of the μ-meson from π-meson decays is about 600 microns. A study of the grain density in C-2 plates, gap density in G-5 plates, and the number and energy of the δ-rays along the short μ-meson tracks indicates that the μ-mesons were ejected from the π-decays with a lower velocity than from normal π-μ decays. It is possible to explain the short range of the μ-meson in 4 of the events and the long range of the μ-meson in the 2 events by assuming that the π-meson decayed in flight. The grain density or gap density along the μ- and π-meson tracks in the remaining 8 events is inconsistent with the assumption that the short range of the μ-meson is due to the decay in flight of the π-meson. If a correction is made for the thickness of the emulsion, the probability that a μ-meson from a stopped π-meson decay will have a range less than 480 microns is found to be $3·3 \pm 1·3 \times 10^{-4}$. This probability is in general agreement with theoretical predictions based upon the assumption that a soft photon is occasionally emitted from the π-μ decay resulting from the charge acceleration of the μ-meson. A.

539.18

7175. A diffusion cloud chamber study of pion interactions in hydrogen and helium. E. C. FOWLER, W. B. FOWLER, R. P. SHUTT, A. M. THORNDIKE AND W. L. WHITTEMORE. *Phys. Rev.*, **91**, 135–49 (*July* 1, 1953).

A description is given of the operation of a high-

pressure diffusion cloud chamber filled with hydrogen or helium and exposed to pion beams of both signs and energies near 60 and 100 MeV. Interactions occurring in the gas filling are investigated. The cross-sections found in hydrogen agree with the results of others, including the large difference between the cross-sections for positive and negative mesons. In helium the total cross-sections are 89 ± 18 and 207 ± 27 mb with beams at 60 and 105 MeV, respectively. These cross-sections include elastic and inelastic scattering, charge exchange and absorption. The charge exchange cross-sections, estimated at 20 and 60 mb for the two respective energies, are much larger than observed by others for different nuclei. Assuming that the mesons interact with the individual nucleons in the nucleus, an approximate calculation shows that a fairly consistent picture can be obtained making use of phase shifts determined by Anderson, Fermi *et al.* for meson scattering on hydrogen. A.

539.18

7176. Angular distribution of pions scattered by hydrogen. H. L. Anderson, E. Fermi, R. Martin and D. E. Nagle. *Phys. Rev.*, **91**, 155–68 (*July* 1, 1953).

The angular distribution of pions scattered by liquid hydrogen has been studied using the collimated pion beams from the Chicago synchrocyclotron. Differential cross-sections have been measured for the laboratory angles 45°, 90° and 135° for positive pions of energies 78 MeV, 110 MeV and 135 MeV, and for negative pions of 120 MeV and 144 MeV. For negative pions, separate results were obtained for the elastic scattering and for the charge exchange scattering. The scattering of positive pions and charge exchange scattering of negative pions show a larger intensity in the backward direction. The elastic scattering of negative pions is mostly forward. The results have been interpreted in terms of phase shift analysis on the assumption that the scattering is mainly due to states of isotopic spins $\frac{3}{2}$ and $\frac{1}{2}$ and angular momenta $s_{\frac{1}{2}}$, $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$. The experimental results are represented quite accurately by the following phase shifts expressed in degrees for the angular momentum states in the order indicated above: at 120 MeV, phase shifts ∓ 15, ± 4, ± 30 for isotopic spin $\frac{3}{2}$ and ± 9, ∓ 3, ± 2 for isotopic spin $\frac{1}{2}$; at 135 MeV, ∓ 14, ± 5, ± 38 for isotopic spin $\frac{3}{2}$ and ± 10, ∓ 5, ± 2 for isotopic spin $\frac{1}{2}$. A.

539.18

7177. The decay of a neutral V particle into two mesons. B. Dayton and D. Willard. *Phys. Rev.*, **91**, 348–50 (*July* 15, 1953).

An unusual example of the decay of a neutral V-particle has been observed in a multiplate cloud chamber operated at 10 600 ft. From this event, it is uncertain if the decay is a two- or three-body process, though in either case neither of the charged decay products can be as heavy as a proton. If a two-body decay is assumed, the event may be completely and consistently described according to either of the following decay schemes: $V_2^0 \rightarrow \pi + \pi + Q$, $V_2^0 \rightarrow \pi + \mu + Q$. The corresponding Q values are approximately 185 MeV and 150 MeV, respectively. A.

53

7178. Study of neutral V particles observed i multiplate cloud chamber. H. S. Bridge, C. Pey B. Rossi and R. Safford. *Phys. Rev.*, **91**, 36 (*July* 15, 1953).

In a series of pictures taken with a multiplate cl chamber the decay of a number of neutral V-part which originated in nuclear interactions produ inside the cloud chamber was observed. Mos these V-particles were found to decay into a pr and a π-meson with a Q value of 37 MeV. Str evidence is presented to support the hypothesis no neutral secondary particle is produced. The time was found to be $(3 \cdot 5 \pm 1 \cdot 2) \times 10^{-10}$ sec. H neutral V-particles were found which certainly bel to a different group. The decay products of th particles are probably two π-mesons. The na and energy of the nuclear interactions which prod neutral V-particles are discussed.

53

7179. The decay of the τ-meson. R. H. Dal *Proc. Phys. Soc.* [*London*] *A*, **66**, 710–13 (*Aug.*, 19 The applicability of the hypothesis of cha independence is discussed for the τ-meson. consequence of this hypothesis is that the freque of charged τ-meson decay leading to a single char π-meson must exceed one-quarter of that of established decay into three charged π-mesons.

539.

7180. Variation of the condensation factor of m cular jets of antimony and cadmium as a function of support and of the thickness of the layer. F. Devienne. *J. Phys. Radium*, **14**, 257–9 (*April*, 19 *In French.*

Continuing earlier work [Abstr. 3022, 6067 (195 the use of radioactive isotopes is applied to a m detailed study of the effect of the nature of the co densing surface on the condensation factor of jets antimony and cadmium molecules. The factor found to vary widely for different surfaces especia when the condensed layer is thin, and to increase the thickness of the layer increases. All the measu ments were carried out at room temperature. J. IBA

539.1

7181. Measurements of the distribution of therm neutrons and Rh-resonance neutrons in isotope chan 5–11 by means of foil activation. K. Steenbe *JENER Rep.*, *No.* 6, 5 *pp.* (1951).

Rhodium foils and the Cd difference method w used for the survey. J. M. CASS

539.1

7182. Artificial synthesis of the neutron and future. R. d'Aubry de Puymorin. *Euclides* [*Madr* **12**, 411–13 (*Oct.*, 1952) *In French.*

Since the neutron is known to be β-radioactive w a maximum energy of 782 keV, the possibility of t reverse of this process, the synthesis of a neutr may be considered. The author suggests that certa observations by J. J. Thompson on electrodeless d charge in gases and recent conclusions by Rayle [Abstr. 1222 (1947)] that the energy available electrical discharge is sometimes of higher th chemical order may have been the result of end thermic synthesis of neutrons and their subseque decay. NUCLEAR SCIENCE ABSTRAC

539.185

The influence of a cadmium sheet on the bution of neutrons in graphite. N. G. SJÖSTRAND. *Fys.*, **6**, *Paper* 48, 496–512 (1953).

e Boltzmann diffusion equation was treated by pherical harmonic method. A rapidly convergent ion was found, and checked by an experiment. Cd cross-section had to be given a rather low e, probably because the theory ignores the selec- absorption of the slower neutrons. J. M. CASSELS

529.185

The scattering of slow neutrons by *ortho-para*-hydrogen. A. T. STEWART AND G. L. RES. Letter in *Phys. Rev.*, **90**, 1125 (*June* 15,).

e total cross-sections for very slow neutrons have re-measured. The results lead to a coherent ering amplitude of $(3{\cdot}80 \pm 0{\cdot}05) \times 10^{-13}$ cm.

J. M. CASSELS

539.185

The interaction of 14-MeV neutrons with ons and deuterons. J. C. ALLRED, A. H. ARM- NG AND L. ROSEN. *Phys. Rev.*, **91**, 90–9 (*July* 1,).

uclear emulsions in conjunction with a neutron mator have been used to measure the differential s-section as a function of angle for the elastic ering of monoenergetic 14 MeV neutrons by ons and by deuterons. Measurements were ied out in the angular regions corresponding to rons being scattered at angles between 48° an 5° in the centre-of-mass system by protons and een 46° and 176° in the same co-ordinate system leuterons. The *n–p* scattering data are consistent isotropic scattering in the centre-of-mass system, are in excellent agreement with the data of schall and Taschek. The *n–d* scattering data are ngly anisotropic. The shape of the angular ribution of the neutrons elastically scattered by erons may be inferred from the differential cross- ions in millibarns for the following laboratory es: 2°, 435 ± 28; 10°, 342 ± 27; 20°, 78 ± 9·3; 38 ± 4·2; 40°, 59 ± 5·2; 50°, 104 ± 9·0; 60°, ± 12; 65°, 142 ± 14. Strong evidence for the tion $D(n, 2n)H^1$ has been found and an attempt etermine the energy and angular distribution of the ntegration protons was moderately successful. A.

539.185

6. Thermal neutron–proton capture. S. P. RRIS, C. O. MEUHLHAUSE, D. ROSE, H. P. SCH- DER, G. E. THOMAS, JR AND S. WEXLER. *Phys.* ., **91**, 125–9 (*July* 1, 1953).

Measurement of the thermal neutron capture s-section of hydrogen has been effected by a parison with boron using the technique of pile llation. The 2200 m/sec value obtained, 0·332 b, a 2% uncertainty resulting primarily from the ct of neutron moderation by hydrogen. However, result indicates an exchange moment contribution he cross-section of $\sim 6 \pm 3\%$. A.

539.185 : 535.42

7. The theory of neutron diffraction by gases. I. K. POPE. *Canad. J. Phys.*, **30**, 597–623 (*Sept.*, 2).

n expression for the total, elastic and inelastic, differential cross-section for scattering of thermal neutrons by a rigid polyatomic molecule is derived. In summing over the final rotational states of the molecule the change in energy of the neutron is assumed negligibly small compared to the neutron's initial energy. The validity of this approximation is discussed. The rigidity of the molecule is then relaxed and the expression obtained for the cross-section amended to take account of the vibrational motion of the nuclei. It is shown that the elastic scattering from a vibrating molecule is equivalent to that from a set of uncoupled anisotropic oscillators placed at the mean nuclear sites. Detailed results are given for spherical top molecules of the type YX_4. Good agreement is found with the experimental pattern of carbon tetrafluoride but not with that of methane. A.

539.185 : 537.534.74

7188. Elastic scattering of protons and neutrons by deuterons. R. S. CHRISTIAN AND J. L. GAMMEL. *Phys. Rev.*, **91**, 100–21 (*July* 1, 1953).

Phase shifts for *p–d* and *n–d* scattering are calculated in Born approximation for partial waves with $l \geqslant 1$. These are used as a starting point for a phase shift analysis of the *p–d* data in the energy range 0–10 MeV. For $l \geqslant 1$, the phase shifts resulting from the phase shift analysis agree with those calculated in Born approximation. The ^4S and ^2S phase shifts have a reasonable energy dependence; that is, the "$k \cot \delta$" plots are smooth functions of the energy and extrapolate to a set of scattering lengths near one of the known sets of *n–d* scattering lengths. It is concluded that the correct set of *n–d* scattering lengths is $a_4 = 6{\cdot}2 \pm 0{\cdot}2 \times 10^{-13}$ cm, $a_2 = 0{\cdot}8 \pm 0{\cdot}3 \times 10^{-13}$ cm. Since this is in disagreement with some previous theoretical conjectures, the scattering lengths and *S* phase shifts in the energy region 0–10 MeV are calculated using a variational method with neglect of polarization (a theoretical estimate of the effect of polarization is made) and the results support the conclusion. *N–d* angular distributions are calculated and compared with experiments. The agreement of the theoretical results with the experimental ones provides a strong *a fortiori* justification of conclusions drawn from the theory about the importance of the internucleonic potentials in low-energy *p–d* and *n–d* scattering. The scattering is nearly independent of the odd-parity *n–p* potentials and of the forces between like particles. Furthermore, it is nearly independent of the shape of the ^3S and ^1S *n–p* potentials. However, the ^2S scattering length is sensitive to the singlet even-parity *n–n* potential, and is calculated as a function of the depth of this potential. It is insensitive to other *n–n* potentials. A.

539.185 : 537.533.74

7189. A search for polarization of high energy neutrons. J. M. DICKSON AND D. C. SALTER. *Proc. Phys. Soc.* [*London*] *A*, **66**, 721–8 (*Aug.*, 1953).

An attempt has been made to detect polarization effects in *n–p* scattering. A Be target bombarded by protons was used to produce "polarized" neutrons, and a search was made for asymmetry when these neutrons were scattered by hydrogen. A polarization effect of $-1{\cdot}6\% \pm 2{\cdot}1\%$ was observed, which is to be compared with a predicted effect of $+6\%$. It is concluded that either (i) little polarization is produced

in n–p scattering or (ii) the polarization effect is smeared out in some way when the elementary collision takes place inside a Be nucleus. A.

539.185.08

7190. Measurements of neutron densities in the JEEP by activation of Na_2CO_3 and absolute counting of the activity. K. STEENBERG. *JENER Rep., No.* 8, 7 *pp.* (1952).

The β–γ coincidence method used for counting the Na^{24} activity is described and discussed. The results are compared with others obtained by activation of NaI crystals. J. J. WILKINS

539.185.08

7191. Efficiency of the long boron counter for fast neutrons. S. A. KUSHNERIUK. *Canad. J. Phys.*, **30**, 402–11 (*Sept.*, 1952).

The efficiency is calculated as a function of the incident neutron energy using the two-group model of neutron diffusion in conjunction with the age and exponential approximations for the slowing down of neutrons. The neutron energies considered are $\leqslant 10$ MeV. Results are summarized graphically for several counter geometries. A.

539.185.08 : 543.712

Measurement of moisture content by neutron counting. *See Abstr.* 7265

539.185.08 : 621.318.572

7192. The development of a neutron spectrometer for the intermediate energies. F. S. GOULDING, J. C. HAMMERTON, M. G. KELLIHER, A. W. MERRISON AND E. R. WIBLIN. *Instn Elect. Engrs Paper* 1528, 12 *pp.* (1953) [To be published also in *Proc. Instn Elect. Engrs*].

A very brief statement of the problems of nuclear reactor design prefaces an account of some of the nuclear-physics measurements necessary. The time-of-flight neutron spectrometer installed at the Atomic Energy Research Establishment is described in detail with reference to these measurements. The performance of the machine, which makes use of a 3·2 MeV linear electron accelerator as neutron source, is shown in comparison with that previously published for other spectrometers. It is shown that the energy resolution obtainable at energies over 10 eV with the A.E.R.E. spectrometer is rather better than has previously been available for comparable counting rates. This is illustrated by comparison of experimental observations of the Co total neutron cross-section in the neighbourhood of a scattering resonance at 120 eV. A.

STRUCTURE OF SOLIDS 539.2

539.211

7193. Surface roughening and oxidation of galena cleavage face in a vacuum furnace under limited air supply. H. HAGIHARA. *J. Phys. Soc. Japan*, **8**, 406–16 (*May–June*, 1953).

Surface structures of galena cleavage face heated at reduced air pressures 10^{-2}–10^{-3} mm Hg, and at temperatures 100°–600°C, were studied by electron diffraction. Surface roughening commences at 3[illegible] with the release of sulphur in combination with oxy[illegible] The roughened surface is bounded by the {100[illegible] facets. Extra structure due presumably to some e[illegible] of the enriched lead atoms was also observed. [illegible] to the oxidation product, epitaxially oriented [illegible] sulphate ($PbSO_4$), or the suboxide (Pb_2O), crystal[illegible] were obtained at temperatures below 400°C. For [illegible] latter, the needle-like external shape was ded[illegible] from the analysis of the diffraction spot. At [illegible] 400°c randomly oriented suboxide or the yel[illegible] oxide (PbO) crystallites were observed. With [illegible] complete evaporation of the crystal at 600°C si[illegible] powder remained as the residue.

539.[illegible]

7194. The mechanism of glass polishing. J. [illegible] SMITH AND J. G. HOOLEY. *Canad. J. Technol.*, [illegible] 37–41 (*Feb.–March*, 1953).

In an effort to determine whether glass flows w[illegible] polished, uranium glasses were fused to nonuran[illegible] glasses and polished in a direction from the activ[illegible] the inactive side. Autoradiographs of alpha tra[illegible] were taken before and after to detect any transfe[illegible] glass. The method would detect a uniformly flo[illegible] layer 4 Å thick if it were over a distance greater t[illegible] 0·2 mm. No evidence for such a flow was found[illegible] the case of a typical silicate or phosphate g[illegible] polished with a water slurry of ceric oxide or rou[illegible] Radioactive ceric oxide was also used to polish n[illegible] active glass. If the contact temperature approach[illegible] the softening point of the glass and caused flow, th[illegible] some of the ceric oxide might become incorpora[illegible] in the surface. The amount was less th[illegible] 4×10^{-8} g/cm².

539.[illegible]

7195. Self-diffusion at silver surfaces. W. [illegible] WINEGARD AND B. CHALMERS. *Canad. J. Phys.*, [illegible] 422–9 (*Sept.*, 1952).

The surface self-diffusion of silver on spec[illegible] crystallographic surfaces of silver single cryst[illegible] and on polycrystalline specimens was investigat[illegible] Various methods of surface preparation were us[illegible] and the general conclusion was reached that surfa[illegible] diffusion is accelerated during changes of surfa[illegible] shape. The theory is advanced that "surfac[illegible] diffusion takes place by a lattice vacancy mechanis[illegible] an abnormally high concentration of lattice vacanc[illegible] is believed to be necessary for changes of surfa[illegible] shape to occur. This accounts for the accelerat[illegible] surface diffusion observed under these conditions.

539.217 : 537.311.[illegible]

7196. Diffusion of lithium into germanium a[illegible] silicon. C. S. FULLER AND J. A. DITZENBERGE[illegible] Letter in *Phys. Rev.*, **91**, 193 (*July* 1, 1953).

Measurements were made with p-type single crysta[illegible] of Ge and Si at temperatures between 450 and 1000° by a method previously described [Abstr. 5114 (1952[illegible] The diffusion coefficient of Li in Ge was found obey the equation $D = 13\times10^{-4}\exp(-10\,700/RT$[illegible] and of Li in Si, the equation $D = 94\times10^{-4}$ ex[illegible] $(-18\,100/RT)$ cm²/sec. The presence of Cu in th[illegible] Ge had no appreciable effect on D. Measuremen[illegible] were also made of the solubility of Li in Si as [illegible] function of temperature. A. D. LE CLAIR

539.217.1 : 624.131

. Consolidation around pore pressure meters. DE JOSSELIN DE JONG. *J. appl. Phys.*, **24**, 922–8 ?, 1953).

esponse of a pore pressure meter on variation oading conditions of the surrounding soil is rded by the necessity that pore water has to enter instrument. This property is introduced as an ument coefficient influencing the boundary litions. With regard to the surface of the instru- t, two types are considered: a rigid type and a rnous type. At $t = 0$ for unit step loading, olidatation has not yet started and the response he instrument depends on the shear modulus of only. Calculation of response as a function of involves three-dimensional consolidation theory is established with the aid of spherical solutions simple harmonic and unit step loading conditions. A.

539.23 : 548.538

8. Crystal growth and orientation in deposits ensed from the vapour. D. M. EVANS AND H. MAN. *Acta cryst.*, **6**, 731–8 (*Nov.*, 1952).

he nature of the crystal orientation in deposits of Cd, Sb, Bi, Fe, NaCl, NaF and PbS, condensed n the vapour upon smooth substrates initially at m temperature, is investigated by electron diffrac- n. The effects of substrate roughness, vapour- am obliquity, deposit thickness, crystal habit and bility of the deposit atoms are investigated. terials (Zn, Cd, Sb, Bi, NaCl) having high atomic bility have initially a densely populated plane on average parallel to the mean substrate plane. ther limitation of azimuthal orientation and slight ination of the mean axis from the substrate normal ound at the surface of thick deposits, resulting n the preferred growth of those crystals whose n faces are most nearly normal to the oblique our stream. Materials (Fe, NaF, PbS, CaF_2, Al) n low mobility have little or no orientation in thin rs, and at oblique vapour incidence, as the deposit kness increases, develop one-degree orientation n an oblique axis. It is concluded this oblique ntation originates from the fine-scale roughness the deposit surface, followed by attainment of reciable atomic mobility, leading to preferred wth of those crystals having free surfaces in the n of characteristic faces. A.

539.23 : 548.7

9. The structure of thin aluminium-silver layers. GÖTTSCHE. *Z. Phys.*, **134**, *No.* 4, 504–16 (1953) *In man.*

he high-vacuum apparatus used for the deposition evaporation of thin single-crystal layers of the ic alloy Al—30% Ag on hot NaCl is briefly cribed and illustrated. The layers were removed n the substrate and examined by electron diffrac- n. The patterns obtained are discussed in some il. Satellites occur. These arise partly from the agonal (γ) phase which is formed during the densation and which is orientated in a definite relative to the cubic ([111] is parallel to [0001]) partly to lattice faults produced by the neigh- ring growth of the two phases. S. WEINTROUB

539.23 : 548.7

7200. The structure of thin silver layers. H. GÖTTSCHE. *Z. Phys.*, **134**, *No.* 5, 517–25 (1953) *In German.*

A comparison is made of the diffraction diagrams of Ag–Al alloy and pure Ag. It is shown that thin evaporated layers of silver exhibit no evidence of the hexagonal silver phase. The influence of grating irregularity and folding over is studied. The details of the construction of the reciprocal lattice are given. This is constructed with the help of rhombohedral co-ordinates. S. TOLANSKY

539.26

7201. X-ray line broadening from precipitation in Cu–Fe alloys. T. S. HUTCHISON. Letter in *J. appl. Phys.*, **24**, 813–14 (*June*, 1953).

Powder photographs of alloys containing between 0·4 and 1·34 wt% Fe, which had been annealed at 850°C (3 hr) and slowly cooled to room temperature, showed (1) lines indicating the presence of some precipitated body-centred cubic Fe in particles of $\sim 10^{-5}$ cm, (2) a broadening of the Cu lines by amounts proportional to the Fe content and larger than could be accounted for by possible inhomogeneities in composition of the dilute Fe solid solution (max. 0·26%): extrapolation to zero Fe content gave the line width found with pure Cu. The possible mechanism of the broadening is briefly discussed. A. D. LE CLAIRE

539.26

7202. X-ray stress-measurement method, with examples of application. A. SCHAAL. *Schweiz. Arch. angew. Wiss. Tech.*, **19**, 211–17 (*July*, 1953) *In German.*

Fundamentals of measurement of stresses by X-ray diffraction are dealt with, giving special consideration to the various types of Debye–Scherrer lines occurring in practice, and to the accuracy of measurement connected with them. By corresponding measures (covering half the film, and, after exposure, turning round the film by 180° and covering the exposed half) it can be seen by inspection whether the deformation is by tension or by compression, and whether high or low, which is important for application. Examples show for what sort of examination the X-rays method is especially useful. A.

539.27

7203. A chemical temperature determination of specimens in the electron microscope. S. YAMAGUCHI. *Z. Phys.*, **134**, *No.* 5, 618–21 (1953) *In German.*

The temperature of the specimen is estimated by observing the behaviour of $NaHCO_3$ and $KHCO_3$ in the electron beam and checking the observations by electron diffraction photographs. Since the former, for which the temperature of decomposition is 30°C, decomposes after about 5 minutes and the latter, for which the corresponding temperature is 63·7°C, does not decompose after 30 minutes, it is concluded that the specimen temperature under the conditions employed is between 30° and 60°C. J. THEWLIS

539.27

7204. Electrode contamination in electron optical systems. K. M. POOLE. *Proc. Phys. Soc.* [*London*] *B*, **66**, 542–7 (*July*, 1953).

The results of a brief study of the origin and mode

of formation of high-resistance films on electrodes of demountable systems are presented. Evidence is given that the films are produced by the dissociation of organic molecules into radicals by electron bombardment and the polymerization of the latter. It is shown that, except where the partial pressure of organic molecules is 10^{-4} mm Hg or more, the process takes place in condensed layers of organic substances, that the nature of the electrode material is not important, and that a beam potential of a few volts is sufficient. Above 300 V beam potential only a low-resistance deposit is formed; no deposit is found if a temperature of 250°C or more is maintained. A qualitative comparison of the deposits originating from various vacuum seals in common use is described. A.

539.27 : 548.74

7205. Techniques for the electron microscopy of crystals. I. M. Dawson. *Brit. J. appl. Phys.*, **4**, 177–81 (*June*, 1953).

New electron microscopy techniques and modifications of existing techniques are described and discussed with reference to the examination of crystals. Methods of preparation of crystals, replica techniques and shadowcasting are fully examined. Crystals of a suitable size for examination in the electron microscope can be grown by the evaporation of saturated solutions of concentration 0·2–0·5%. The importance of obtaining crystal surfaces uncontaminated by amorphous material is discussed and a technique for freeze-drying protein crystals in such a way as to minimize this surface contamination is described. By a modification of standard replica procedures for electron microscopy replicas of organic crystals can be prepared on the microscope specimen mount without intermediate manipulation. This *in situ* replica technique has considerable advantages in studying the details of crystal surface structure. This method can be used to detect molecular steps of 12–15 Å height on crystal faces. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.3 : 532.51 : 538.3 : 530.145

Integral representation of the field vector. *See Abstr.* 6456

539.31 : 539.37 : 535.55

Elasto-plastic stress-optical effect in silver chloride single crystals. *See Abstr.* 6678

539.312

7206. Dynamic compliance, dynamic modulus, and equivalent Voigt and Maxwell models for polyisobutylene. H. Leaderman and R. S. Marvin. Letter in *J. appl. Phys.*, **24**, 812–13 (*June*, 1953).

The main features of the visco-elastic behaviour of polyisobutylene of weight-average molecular weight $1{\cdot}56\times10^6$ are those of a spring-dashpot model consisting of three Maxwell elements in parallel, with relaxation times of the order of 10^{-6}, 10^4 and 10^6 sec. Their equivalent description in terms of Voigt elements has certain advantages. J. G. OLDROYD

539.312 : 5

7207. Dynamic mechanical properties of poly butylene. E. R. Fitzgerald, L. D. Grandine, Jr J. D. Ferry. *J. appl. Phys.*, **24**, 650–5 (*May*, 195

Values of complex shear compliance (and rigi have been obtained for a sample of polyisobutyle viscosity-average molecular weight $1{\cdot}35\times10$ 22 temperatures from −45 to 100°C and at a 20 frequencies from 30 to 5000 c/s. Measurem were made by means of the transducer metho Fitzgerald and Ferry with a precision of ±2% are estimated to be accurate to within ±3% as denced by agreement obtained between 7 diff samples of widely varying dimensions. Values o real part of the complex shear compliance J' from $3{\cdot}1\times10^{-7}$ cm²/dyne at 99·9°C to $1{\cdot}0\times1$ cm²/dyne at −44·6°C. The frequency dependen the loss tangent J''/J' indicates the presence of a broad maximum of 1·7 at −10 to −5°C an second, smaller maximum at lower temperat This second maximum is also evident in a plo J''/J' at a fixed frequency against temperature. wide temperature and frequency ranges of measurements have provided an essentially com experimental description of the dispersion regio polyisobutylene corresponding to the transition a rubber-like elasticity to that of a hard glass.

539.312 : 54

7208. The relaxation distribution function of isobutylene in the transition from rubberlike to glass behavior. J. D. Ferry, L. D. Grandine, Jr E. R. Fitzgerald. *J. appl. Phys.*, **24**, 911–16 (1953).

The steady flow viscosity of a sample of poly butylene of viscosity-average molecular weight million, distributed by the National Bureau Standards, has been measured from 15° to 10 Its logarithm is a linear function of $1/T^2$. Applica of the method of reduced variables to dyna mechanical data from −45° to 100°C, previo reported for this polyisobutylene (preceding abstra yields composite curves reduced to 25°C for the and imaginary parts of the complex compliance complex shear modulus; the real part of the com dynamic viscosity; and the mechanical loss tang The latter exhibits a broad and peculiarly asymme maximum. The reduced time scale extends from 10^{-9} sec. The reduction factors a_T obtained in way are slightly higher than those derived either f the viscosity or from stress relaxation measurem of Tobolsky and associates. The distribution fu tions of relaxation and retardation times have b calculated by second-approximation methods and t detailed shapes are defined in the transition reg between rubberlike and glasslike behaviour. relaxation distribution function is compared with idealized distribution of Tobolsky.

539

7209. Evaluation of the relaxation periods from torsional vibrations. E. Jenckel, H. Hertog E. Klein. *Z. Naturforsch.*, **8a**, 255–66 (*April*, 19 *In German.*

The theory of free vibrations of the Maxwel bodies enables the measurement of the damping of polymer substances to be used for evaluating

ation periods as function of temperature and for determination of the shear moduli. These etical results have been applied to the measure- s of the logarithmic-decrement/temperature de- ence of polyurethane, polystyrene, Astralon and n. It is possible to obtain different material ants, the shear moduli, relaxation periods and eats of activation. No relationship has been d between the freezing temperature and the mum damping; the freezing temperature is, ver, doubtless the temperature for which the erature coefficients of the relaxation periods ge almost discontinuously. F. LACHMAN

539.32

Acoustic wave velocities, elastic constants and e characteristic temperature for polycrystalline d. C. S. SMITH AND W. E. WALLACE. Letter in *em. Phys.*, **21**, 1120 (*June*, 1953).

ngitudinal and transverse wave velocities were ured, by the ultrasonic pulse method, in a 50·6 % alloy, leading to values for Young's mod. = $\times 10^{11}$, shear mod. = $1{\cdot}8\times10^{11}$ and adiabatic mod. = $4{\cdot}78\times10^{11}$ dyne/cm^2. The isothermal mod. was calculated to be 4·65 dyne/cm^2 and Debye temperature 220°K. A. D. LE CLAIRE

539.32 : 541.64

The effect of cross-linking on the elastic ulus of Polythene. A. CHARLESBY AND N. H. COCK. *Proc. Roy. Soc. A*, **218**, 245–55 (*June* 25,).

oung's modulus for Polythene, cross-linked by irradiation, has been measured by both static and amic means. Below about 115°c (the usual ing-point) the modulus decreases with tem- ture. Above this temperature it increases again, greement with the theory of rubber-like elasticity, pt for very high degrees of cross-linking, corre- ding to a glass-like structure. The effect of ation is both to produce cross-linking, and to roy crystallinity. The latter effect predominates w about 4% cross-linking, and a more flexible erial is obtained at room temperature. The erved elastic properties below 115°c are ascribed art to the attraction of neighbouring chains; the vation energy required to break these attractive es is estimated at about 0·25 eV. A.

539.373

Pure gliding of metal crystals. H. KANZAKI. er in *J. appl. Phys.*, **24**, 811 (*June*, 1953).

y employing a more satisfactory method of loading a more careful analysis of the strain, it is shown the difference between the stress-strain curves ined in pure gliding and in the usual tensile tests t so large as reported by Röhm and Kochendörfer *Metallk.*, **41**, 265 (1950)]. A. D. LE CLAIRE

539.374

Allowance for temperature in the equations of ticity theory. N. S. FASTOV. *Dokl. Akad. Nauk R*, **85**, *No.* 1, 67–70 (1952) *In Russian.*

is shown that, in the tensor formula for plastic rmation, $D_\omega = \psi D_G$ (D_σ, D_G = stress and in deviators respectively), ψ_0 (and hence the shear dulus $\psi/2$), is a linear function of the temperature, is not independent of it as usually supposed. R. C. MURRAY

539.4.016

7214. A theoretical calculation of the stored energy in a work-hardened material. A. N. STROH. *Proc. Roy. Soc. A*, **218**, 391–400 (*July* 7, 1953).

The amount of energy stored in a cold-worked material is calculated on the assumption that the energy is due to piled-up groups of dislocations. It is found that a small percentage of the work done in deformation is stored, and that the amount of energy stored is proportional to the strain. These predictions are in reasonable agreement with the experimental results, particularly for large strains. For smaller strains it is possible that much of the stored energy is due to the formation of vacancies and interstitial atoms. The model assumed also accounts for the observed release of stored energy before softening of the metal takes place. A.

539.4.016.2

7215. Measurements of stacking faults in cold worked alpha-brass. B. E. WARREN AND E. P. WAREKOIS. Letter in *J. appl. Phys.*, **24**, 951–2 (*July*, 1953).

The decrease in separation of the (111) and (200) reflections and the increase in separation of the (222) and (400) reflections which Paterson [Abstr. 7684 (1952)] predicted would be produced by stacking faults on (111) planes in face-centred cubic metals, were observed and measured on cold-worked α-brass. It was deduced from the measurements that there is a stacking fault every 40 (111) planes, which is interpreted as meaning that slip occurs on one in every 20 planes. The major part of that contribution to the broadening of X-ray reflections which is attributed to particle size may be due solely to stacking faults. A. D. LE CLAIRE

539.4.016.2 : 539.32 : 539.67

7216. Internal friction and Young's modulus of cold-worked copper single crystals. J. WEERTMAN AND J. S. KOEHLER. *J. appl. Phys.*, **24**, 624–31 (*May*, 1953).

The internal friction and Young's modulus of single crystals of copper were measured as a function of strain amplitude after they were subjected to various amounts of cold work and different annealing treatments. It was found that the position of the peak in the internal friction *v.* cold-work curve was dependent upon the strain amplitude of the measurement. No minimum in the Young's modulus *v.* cold-work curve was found as contrasted with Lawson's result for polycrystalline copper. A minimum was found in the internal friction *v.* annealing time curve, and a maximum was found in the corresponding Young's modulus curve. The results are semiquantitatively explained using a dislocation model. A.

539.42 : 548.0

7217. A single crystal extensometer. A. J. KENNEDY. *Rev. sci. Instrum.*, **24**, 505–7 (*July*, 1953).

A simple mechanical network is described which when loaded with a constant weight, maintains constant stress on the slip planes of a single crystal extending under creep. It also automatically rotates the grips to eliminate end distortion. The problem of extending the crystal along a fixed time is examined. A.

539.434

7218. On the generality of the cubic creep function. A. J. KENNEDY. *J. Mech. Phys. Solids*, **1**, 172–181 (1953).

The transient creep function $\varepsilon = \beta t^m$, where ε is the creep strain at a time t after loading, and β and m are constants, is shown to have a wide application to a variety of metallic and non-metallic materials, with m generally having values near to $\frac{1}{3}$. The behaviour of a simple mechanical model, composed essentially of bi-stable units, is shown to approximate to the type of creep observed in real materials. A statistical approach is outlined. A. J. KENNEDY

539.434

7219. Creep of copper under stress pulses. A. J. KENNEDY. Letter in *Nature* [*London*] **171**, 927–8 (*May* 23, 1953).

It is shown that the observed effects of (*a*) varying the stress wave-form, with a fixed frequency, and (*b*) varying the frequency with a fixed wave-form are each in accord with the mathematical analysis already developed [Abstr. 7615 (1952)] to fit earlier observations on lead. A. J. KENNEDY

539.434

7220. Transient creep in pure metals. O. H. WYATT. *Proc. Phys. Soc.* [*London*] *B*, **66**, 459–80 (*June*, 1953).

A constant-stress testing machine of small inertia and with continuous strain recording has been built. The loading was by air contained in metallic bellows whose wall stiffness was compensated by a "negative spring." The initial strain rate was standardized at 1% per sec. Polycrystalline copper and aluminium have been investigated between −196°C and 140°C. At low temperatures, the creep curves fitted $\varepsilon = \alpha \log t + c_1$; at higher temperatures they fitted $\varepsilon = \beta t^{1/3} + c_2$. These are called α and β creep respectively. In an intermediate temperature range the curves fitted $\varepsilon = \alpha \log t + \beta t^{1/3} + c_3$. The results have been confirmed for cadmium and commercially pure aluminium, and also for aluminium with only a few grains per specimen. In a series of increment tests the stress was altered by small amounts at various times during a creep curve; in the α range only, the curves after the increments were similar to segments of the parent curve. The effect of testing a specimen at increasing stresses and different temperatures was also investigated; in the α range only, an equation of state, that is $F(\sigma, \varepsilon, d\varepsilon/dt, T) = 0$, was obeyed. A theory of α creep is developed: an exhaustion theory is applied to a metal whose strain hardening is defined by a reference curve. The rise of activation stress during a creep curve and the slope of the reference curve are deduced from the increment and creep tests; and the slope agrees numerically with the stress–strain curve at −196°C. From an equation of state, values of the mean activation energy at a strain rate of 10^{-4} cm/cm.sec, and the frequency of thermal fluctuations are obtained. A.

539.434

7221. Creep and recovery in metals. A. J. KENNEDY. *Brit. J. appl. Phys.*, **4**, 225–33 (*Aug.*, 1953).

A review is made of the experimental evidence available on the nature of the creep and recovery mechanisms in single crystal and polycrystalline metals. This leads to consideration of the character of creep when periods of recovery, under rec stress, are interposed, and it is shown that such conditions have an important effect on the behavio structures and machines, particularly at high st and temperatures. 126 refs.

7222. Plastic and elastic properties of high poly and the kinetic theory of matter. F. H. MÜ *Schweiz Arch. angew. Wiss. Tech.*, **19**, 78–85 (*M* 1953) *In German.*

Qualitative discussion of the rheological beha of high polymers in terms of molecular structure kinetic theory. Mechanical relaxation and creep interpreted as changes in entropy. J. E. CA

539

7223. Anomalies in the field of microhard A. BRAUN. *Schweiz. Arch. angew. Wiss. Tech.* 67–78 (*March*, 1953) *In French.*

A theoretical relation between the elastic and w hardening properties of a metal in tension and variation of hardness with applied load in the r 2·5 g–50 kg, as measured with a pyramidal inde is derived and confirmed by observations on se metals. The dependence of microhardness reac on metallic structure is discussed. J. G. OLDR

53

7224. The velocity and temperature dependenc rubber friction. A. SCHALLAMACH. *Proc. Phys.* [*London*] *B*, **66**, 396–92 (*May*, 1953).

It is shown experimentally that the velocit frictional gliding under constant tangential stres rubber on glass and on silicon carbide cloth is, in first approximation, an exponential function of reciprocal absolute temperature and of the tange stress. It is suggested that frictional gliding of rub is a rate process.

539.62 : 536

7225. Friction and lubrication of surfaces at temperatures. [Reibungsuntersuchungen an geschm ten Oberflächen bei tiefen Temperaturen]. M. BUTSCHIN. *Berlin*: *Akademie-Verlag* (1953) 64 *In German, translated from Russian.*

Four short papers on friction and lubrication low temperatures emphasizing technical importa of investigations. Chapter 1, on dry friction, cusses the influence of physical and chemical surf conditions, including the effect of surface films the real area of contact. Chapter 2 describes exp ments in temperature range +150 to −130°C on static friction of surfaces, lubricated with a num of oils. It is shown that as temperature falls fric first rises with viscosity of the oil, reaching a maxim at a "critical temperature" which is below the melt point of the oil. The subsequent fall of μ is due hardening of lubricant, and friction becomes depend on the mechanical properties of the solid lubrica "Critical temperature" may be used for compar efficacy of lubricants although this is to some ext dependent on the thickness of the solid lubric layer. Chapter 3 shows how the effective te perature range of oils may be extended downwar by the addition of high polymer compound Chapter 4 gives an account of experimental inves gations of the friction of ball-races at low temperatur

J. W. MENT

539.621

Friction on snow and ice. F. P. BOWDEN. *Roy. Soc. A*, **217**, 462–78 (*May* 21, 1953).

experimental study has been made of the on of real ski and of smaller models sliding on and ice at various temperatures. On cold snow tatic friction is high. When the sliding speed is ciable the friction falls to a low value, and iments support the view, put forward earlier, this low friction is due to a localized surface ng produced by frictional heating. Measure- s are made on a variety of surfaces including s, synthetic polymers and waxes. The contact which water makes with the surface is im- nt, and there is evidence that this can decrease g sliding. In general, the solids with a high ct angle give a lower friction. The behaviour is influenced by the relative hardness of ice and of ki surface at the temperature of sliding. Poly- tetrafluoroethylene gives a very low friction on snow and ice under all conditions. A.

539.63

7227. On the theory of internal friction in metals. B. V. PARANJAPE. *Proc. Phys. Soc.* [*London*] *A*, **66**, 572–5 (*June*, 1953).

The absorption and emission of vibrational quanta by the conduction electrons in metals leads to a contribution $\pi^2 \nu F \sigma / K_0 (10^{-3})$ to the internal friction per cycle independent of frequency. This holds only for longitudinal vibrations whose wavelength is sufficiently small compared with the dimensions of the sample. In the above ν is the number of free electrons per atom; σ/K_0 is twice the ratio of the velocity of sound to that of the fastest electron and is of the order 10^{-3}. F is a constant of the order unity; its exact value can be found from the temperature coefficient of the electrical resistivity at high temperatures. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.5 : 536.24

On the mathematics of exchange processes in columns. I. Mathematical solutions and asymp- expansions. S. GOLDSTEIN. *Proc. Roy. Soc. A*, 151–71 (*Aug.* 25, 1953).

e paper is intended as a contribution to the mathe- al discussion of the exchange processes, of heat f matter (as in ion exchange or adsorption), arise when a fluid flows through the pores or along a column containing matter in the solid The exchange is taken to be governed by a r or bilinear or Langmuir-type kinetic exchange tion. The matters dealt with include the solu- of the exchange and conservation equations for initial conditions, mathematical properties of asymptotic expansions for the functions arising, the appearance of the functions in the solutions her physical problems. The discussion of the ematical properties of the functions and their ptotic expansions is needed to establish the onship between solutions on the equilibrium y and those on the kinetic theory, and to find r approximations to the kinetic-theory solutions. A.

541.123.5 : 536.24

On the mathematics of exchange processes in columns. II. The equilibrium theory as the limit e kinetic theory. S. GOLDSTEIN. *Proc. Roy. A*, **219**, 171–85 (*Aug.* 25, 1953).

e mathematical solutions on the equilibrium y (whose relation to the kinetic theory is ex- ed) are set out for certain initial conditions ding elution from an incompletely saturated nn), and it is shown that these solutions are the ct (non-uniform) limits of the corresponding ions on the kinetic theory. It is shown how r approximations to the kinetic-theory solutions may be obtained from previous mathematical results. Mathematically, on the kinetic theory the equation to be solved is a hyperbolic differential equation for which, under certain conditions, the coefficient of the highest derivative occurring is small. On the equilibrium theory the term containing this highest derivative is omitted; the equation remains hyperbolic. A.

541.124

7230. Some theoretical considerations of ether decompositions. B. G. GOWENLOCK. Letter in *J. chem. Phys.*, **21**, 941–2 (*May*, 1953).

The mechanism suggested by Rebbert and Laidler having an initial step $C_2H_5OC_2H_5 \rightarrow C_2H_5 + OC_2H_5$ is compared with the Rice–Herzfeld mechanism with initial step $C_2H_5OC_2H_5 \rightarrow CH_3 + CH_2OC_2H_5$. The stabilities of the various radicals formed are considered by the use of bond dissociation energies and heat of formation data. It is concluded that the available evidence is unable to decide between the two mechanisms for the dissociation.

H. H. GREENWOOD

541.124

7231. A study of the formation of iron percarbide. J. J. MITCHELL. *J. chem. Phys.*, **21**, 1153–9 (*July*, 1953).

Carbon-14-labelled CO was used in a study of the carbiding of reduced iron in the temperature range 170–231°C. It was shown that the percarbide forms around nuclei scattered throughout the iron, that carbon in percarbide volumes is held firmly in place, and that a substantial fraction of the surface of partially carbided iron is occupied by percarbide. A.

541.124

7232. Some observations on the chemical behavior of iodine at low concentrations. M. KAHN AND A. C. WAHL. *J. chem. Phys.*, **21**, 1185–9 (*July*, 1953).

An investigation has been made of the chemical forms assumed by I^{131} initially in the form of iodide ion at low concentration (the order of 10^{-7}M) when it is oxidized under various conditions. Oxidation at

room temperature in 1*f* sulphuric acid solution by dichromate ion or cerium (IV) results in the formation of I_2 and three additional, unidentified, chemical fractions which are not readily exchangeable with I^-, I_2, or IO_3^-. Two of the unidentified fractions are extracted from aqueous sulphuric acid solution by organic solvents, one fraction being converted by aqueous sodium hydroxide to water-soluble forms exchangeable with I_2. At least some of the unidentified fractions probably are the products of reactions between trace impurities, molecular or colloidal, and iodine in an oxidized reactive form such as HIO. These unidentified fractions are quite inert toward oxidation and reduction. When iodide ion at low concentration is treated with a hot sulphuric acid solution of cerium (IV), the principal product is IO_3^-, or a species readily exchangeable with IO_3^-. The IO_3^- formed in this way is readily reduced at room temperature to I^- by a sulphuric acid solution of iron (II). A.

541.124 : 535.33.03

7233. The mechanism of formation of OH, CH and HCO in flame spectra, using deuterium as tracer. H. P. Broida and A. G. Gaydon. *Proc. Roy. Soc. A*, **217**, 60–9 (*June* 9, 1953).

Deuterium has been used as a tracer in studies of the spectra of premixed flames of hydrogen, acetylene and oxygen, both at atmospheric pressure and at very low pressure. A similar technique has also been used with the "flames" due to the reactions of free atoms; these experiments indicate that the exchange between atomic hydrogen and acetylene is not an appreciable factor in producing the observed spectra. The radiation from excited CH and HCO and part of that from OH appears to result from chemical processes, but the radicals are formed by some secondary reactions, not directly in the breakdown of the hydrocarbon. Possible reactions are discussed; excited CH is probably formed from $C_2 + OH$ and excited OH from $CH + O_2$. A.

541.127

7234. Kinetics of reaction between ammonia and oxygen in a quartz vessel. H. Wise and M. F. Frech. Letter in *J. chem. Phys.*, **21**, 948–9 (*May*, 1953).

Measurements at 1096°K indicate that the mechanism of oxidation of ammonia involves first dehydrogenation of the ammonia molecule followed by the oxidation of the hydrogen thus produced. The rate of formation of hydrogen increases with the partial pressure of oxygen but is rapidly oxidized at high oxygen concentrations. At lower oxygen concentrations the hydrogen intermediate, now less rapidly removed, may inhibit the oxidation process, thus accounting for the apparent self inhibition of ammonia. Some experimental details are given.

H. H. GREENWOOD

541.127

7235. Molecular kinetics of hydrogenation and exchange reactions of ethylene at surfaces. K. J. Laidler, M. C. Wall and M. C. Markham. Letter in *J. chem. Phys.*, **21**, 949–50 (*May*, 1953).

Summarizes results obtained by the absolute rate theory. Ethylene is assumed to be absorbed on dual sites and hydrogen atoms on single sites. Ethane may be produced by the reactions of absorbed ethyl radicals formed by the interaction of abso ethylene and hydrogen. The absolute rate cal tions give good agreement with experiment, but ca discriminate between this mechanism and that w assumes that hydrogen can be absorbed only reaction with absorbed ethylene. Calculations the rate of the exchange reaction between ethy and deuterium are incompatible with an ea suggestion that the rate is independent of the ethy pressure and directly proportional to the first po of the deuterium pressure. The results may be f to a square-root dependency on deuterium press and an appropriate mechanism is proposed.

H. H. GREENW

541

7236. On spherical explosion waves in mixture acetylene and air. H. Freiwald and H. Ude. *Acad. Sci.* [*Paris*] **236**, 1741–3 (*May* 4, 1953) *In Fre*

Detonation waves were initiated at the centr spherical rubber balloons (dia. 50, 90, 170 cm) taining C_2H_2-air mixtures. The explosion was ph graphed with a rotating-drum camera (writing sp 0·05 mm/μsec) and a cine camera (6000 frames/ The limits of detonation are 8–19% C_2H_2 and detonation velocity for a mixture containing 12 C_2H_2 is 1920 m/sec; the limits are much narr than for detonation in a tube (4–50% C_2H_2) th the velocity of detonation for a particular mixtu the same. A. SCHOF

541

7237. The iron catalyzed reaction between nitr disulfonate and hydroxylamine monosulfonate i W. J. Ramsey and D. M. Yost. Letter in *J. ch Phys.*, **21**, 957–8 (*May*, 1953).

Neutral solutions of $K_2NO(SO_3)_2$ hydrolyse sl to form N_2O and hydroxylamine sulphonates complex mechanism which the present study additional reactions which may take part in hydrolysis is intended to help elucidate. The ra disappearance of nitrosyl disulphonate ion meas spectroscopically is shown to be of the first o with respect to both the total iron and to the hydr lamine monosulphonate ion concentrations. reaction mechanism in accordance with this resu proposed, and the rate constants for the indivi steps are given. H. H. GREENW

ELECTROCHEMISTRY 541.13

54

7238. Fifty years of electrochemical theory. W Hamer. *J. Electrochem. Soc.*, **99**, 331*C*–343*C* (*L* 1952). Brief survey. 168 references.

541.13 :

7239. Electrochemistry in biology (1922–52). L Longsworth. *J. Electrochem. Soc.*, **99**, 355*C*–3 (*Dec.*, 1952). Brief survey. 29 references.

541

7240. Ion association of 2–1 salts in metha F. M. Sacks and R. M. Fuoss. *J. Electrochem. S* **99**, 483–7 (*Dec.*, 1952).

Conductance curves for many 2–1 salts in metha (and other solvents of intermediate dielectric const

oximate linearity over a fairly wide range of ntration. This linear region is an inflection , produced by a combination of decreasing lity ($c^{\frac{1}{2}}$ terms) and decreasing number of free (c terms) with increasing concentration. It therefore, not be used for extrapolation to Λ_0. ming stepwise association: (a), $A' + B^{++} \rightleftharpoons$; (b), $AB^{+} + A' \rightleftharpoons BA_2$, a method of successive oximations is derived by which Λ_0, k_1 and k_2 e calculated from conductance data. A.

541.133 : 534.21

Calculation of the temperature and pressure cients of conductivity and the ultrasonic effect ilute electrolytes from Onsager's theory. S. ARTT. *J. chem. Phys.*, **21**, 908–11 (*May*, 1953).

hen ultrasonic waves are propagated through rolytes, the periodic adiabatic compressions give o conductance changes which are a measure of emperature and pressure coefficients of conduc- . It is shown that these coefficients can be lated from Onsager's equation for symmetrical- ice electrolytes, if the coefficients at infinite ion are known. Therefore, the magnitude of the sonic effect can be computed. If the temperature icient at infinite dilution is known, then the ure coefficient at infinite dilution may be obtained a measurement of the ultrasonic effect at atmo- ric pressure. The magnitude of the effect is ed for progressive and stationary plane waves in uctivity cells of uniform cross-section. When onductance of the electrolyte is determined with the ultrasonic waves produce two side-band ges of equal amplitude. For $10^{-4}M$ KCl at in a favourable cell, the side-band voltages are puted to be approximately 53 microvolts per sphere acoustic pressure per volt applied. A.

541.135

. Diffusion and convection in electrolysis—A etical review. C. W. TOBIAS, M. EISENBERG AND R. WILKE. *J. Electrochem. Soc.*, **99**, 359C– (*Dec.*, 1952).

nsiders mechanisms of ion transfer, equations eady state mass transfer, the relation between nt density, concentration and electrode potential, eady state diffusion, forced convection, a flat ite disk rotating with a constant angular velocity, past a flat electrode set into a laminar flow of d, turbulent flow over a flat plate electrode, and ral convection. The authors consider it un- mate that Prandtl's boundary layer theory, rns of velocity distribution, and other aspects of odynamic theory have not until recently been duced into electrochemistry. 30 references.

H. H. HODGSON

541.135

. Mathematical theory of the Faradaic admit- e (Pseudo-capacity and polarization resistance). C. GRAHAME. *J. Electrochem. Soc.*, **99**, 370C– (*Dec.*, 1952).

he theory now developed applies only to smooth ogeneous electrodes on which the c.d. is uniform. ble layer impedance is first considered, and the r deals with the effect of concentration changes uced respectively by the non-Faradaic and the alternating component of the Faradaic current upon the capacity of the double layer, with the effect upon the measured Faradaic admittance of concentration changes produced by the non-Faradaic and alternating component of the Faradaic current respectively, and with the relation of the double-layer admittance to the Faradaic admittance. General expressions are then derived relating voltage to current. Finally, the substances present in a system are classified according to the kind of equivalent circuit used to represent them, and the relevant differential equations are derived with their solutions. 22 references.

H. H. HODGSON

541.135

7244. Investigations on the electrolysis of molten aluminates. E. BONNIER. *Ann. Phys.* [*Paris*] **8**, 259–313 (*March–April*, 1953) *In French.*

Presents results of a comprehensive research on the electrolysis of melts of aluminates of Na, Ca, Ba and Mg. Binary mixtures (I) of Na aluminates and cryolite exhibit eutectic points at relatively low temperatures. Addition of Na_2CO_3 to (I) does not affect the equilibrium conditions. Electrolysis of these mixtures yields pure Al in commercially interesting yield. The solubility of several aluminates of Ca in different fluxes has been investigated. Electrolysis of Ca aluminates with cryolite yields Al almost free from Ca. Al/Ca alloys of every percentage can be obtained by using different proportions of $CaCl_2$, CaF_2 and AlF_3. The electrolysis of $Al_2O_3 . BaO + LiF$ yields a ternary Al/Ba/Li alloy. An eutectic point of 920°c has been determined for the system $Al_2O_3 . MgO + Na_3AlF_6$. Alloys of Al and Mg are easily obtained by electrolysis of Mg aluminate with MgF_2. F. LACHMAN

541.135

7245. Effects of the macroscopic electrical charges formed in the interior of solutions and their importance in electrolytic processes. J. LIMA-DE-FARIA. *C.R. Acad. Sci.* [*Paris*] **236**, 1883–5 (*May* 11, 1953) *In French.*

Experiments are described which indicate the effects of the electrical charges formed in the interior of solutions of electrolytes in the regions of discontinuity of the electric field. The relationship between the results and the electrolysis of acids and bases is discussed, and also the mechanism of the abnormal mobilities of the H^+ and OH^- ions. H. H. HODGSON

541.135.2

7246. A generalization of the kinetic theory of Lindemann and Darmois–Sutra concerning the migration of electrolytic ions subjected to a potential gradient. I. CIVAOĞLU AND T. ERBEN *Istanbul Tek. Üniv. Bült.*, **4**, *No.* 1, 37–65 (1951) *In French.*

It is demonstrated that the theory of Darmois and Sutra [Abstr. 2290 (1947)], Sutra [*Rev. gén. sci.*, **56**, 54 (1949)], Darmois [Abstr. 2130 (1951)], which can be looked upon as a special case of the more general theory of Lindemann [*Z. phys. Chem.*, **110**, 394 (1924)] should be generalized by introducing into the calculations the conception of the persistence of velocities. It is also shown that a retardant effect on the motion of an ion, such as that due, e.g. to the dipole nature of the solvent molecules, causes a minimum in the

mobility/ionic-mass curve, which can be explained if one attributes to ions different degrees of hydration. The mobility/ionic-mass curve consists mainly of two branches: that with a vertical asymptote refers to the very mobile ions (H^+, D^+), while that with a horizontal asymptote corresponds to heavier atoms.

F. LACHMAN

541.135.5

7247. A brief summary of hydrogen electrode kinetics. J. O'M. BOCKRIS. *J. Electrochem. Soc.*, **99**, 366C–369C (*Dec.*, 1952).

The following topics are considered: experimental difficulties, including measurements, effect of impurities, and reproducible preparation of clean metal surfaces; reaction paths; dependence of reaction rate on potential; kinetics; criteria of mechanism; explanations including the Bonhoeffer catalytic anomaly, trace impurities and reversible hydrogen electrodes; and electrode kinetics in general. 43 references. H. H. HODGSON

541.135.5

7248. Hydrogen overvoltage on bright platinum. S. SCHULDINER. *J. Electrochem. Soc.*, **99**, 488–94 (*Dec.*, 1952).

A technique was used which allowed the confirmation of surface cleanliness of bright platinum electrodes during overvoltage measurements. As the current density was increased, three consecutive η *v.* i relationships were observed, $\eta = a_1 + b_1 i$ (I), $\eta = a_2 - (0{\cdot}026 \pm {\cdot}003) \log i$ (II), $\eta = a_3 - (0{\cdot}105 \pm {\cdot}015) \log i$ (III). The current density at which the transition from (II) to (III) occurred was dependent on the rate at which hydrogen ion diffused into the double layer. The mechanism of hydrogen overvoltage on platinum is discussed in view of these results. The true area of the platinum electrode was determined from double-layer capacity measurements.

A.

541.135.5

7249. Effect of stress on metal electrode potentials. R. E. FRYXELL AND N. H. NACHTRIEB. *J. Electrochem. Soc.*, **99**, 495–503 (*Dec.*, 1952).

The effect on the electrode potentials of silver and gold has been measured. Tension renders these metals cathodic in aqueous solutions of their corresponding salts. Compression produces changes in the opposite direction. These changes are proportional to the applied load. Quinhydrone and ferrous-ferric electrodes are not affected by stress. The observations cannot be accounted for on the basis of thermodynamic changes produced within the metal. Necessarily, a surface phenomenon is responsible. The condition of the metallic surface is shown to be an important variable, although studies of certain variables within the electrolyte have failed to reveal the nature of polarization. A.

541.135.5

7250. Pulverizability and surface structure of electrolytic solutions. P. BARRET. *C.R. Acad. Sci.* [*Paris*] **236**, 1031–4 (*March* 9, 1953) *In French.*

The author's hypothesis, based on measurements of cathodic pulverizability of different electrolytic solutions in air at atmospheric pressure, viz., that there is an electrical charge of density D in the surface liquid layer at the base of the spark, is claimed to be in accord with the following experimental facts: (1) The absence of pulverization when the solution is the positive pole of the spark, the anodic potential fall being much more feeble than the cathodic one. (2) The decrease of pulverizability with strength of concentration of the electrolyte. (3) The failure of pulverization with fused electrolytes due to the existence of discontinuity in the surface layer.

H. H. HODG

541.

7251. Anodic behavior of iron in H_2SO_4. J. BARTLETT AND L. STEPHENSON. *J. Electrochem.* **99**, 504–12 (*Dec.*, 1952).

Various phenomena associated with the steady s of the cell $Fe|H_2SO_4(2N)|Pt$ are discussed with particular emphasis on the factors governing reproducibility. The formation of a brownish, gelatin coat is observed, but its significance is obscure and appears to have no direct effect upon transie produced by short off-times. An empirical equat has been found which represents the short off-t transients over a relatively wide voltage range. principal points that must be embodied in a the describing the transient behaviour of the cell discussed. The part played by the charging of usual double layer is demonstrated to be of li consequence in the observed transients.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.

7252. The photochlorination of methyl chlo formate in the gas phase. J. H. BRANDY AND D. LE ROY. *J. chem. Phys.*, **21**, 1049–53 (*June*, 1953)

Under similar conditions of concentration and li absorption the rate of the gas phase reaction is alm the same as the rate in carbon tetrachloride soluti studied previously [*J. chem. Phys.*, **17**, 566 (*Ju* 1949)], although the mechanism is somewhat differe The gas-phase reaction is not inhibited by produ and the bimolecular chain termination step consi in the formation of chlorine, rather than mon chloromethyl chloroformate. First-order removal chlorine atoms becomes important at low li intensities. The ratio of the rate constant for hydrog chloride formation to that for first-order chain t mination is the same in the gas phase as in carb tetrachloride solution within the accuracy of measurements.

541

7253. A calorimetric calibration of gamma-r actinometers. C. J. HOCHANADEL AND J. GHORMLEY. *J. chem. Phys.*, **21**, 880–5 (*May*, 1953)

The yield for γ-ray oxidation of ferrous sulph in air-saturated $0{\cdot}4M$ sulphuric acid was found to $15{\cdot}6 \pm 0{\cdot}3$ ferrous ions oxidized per 100 eV absorbe This value was based on calorimetric measureme of cobalt γ-ray energy absorption in water at int sities of 25 r/sec, 74 r/sec and 225 r/sec. The yi

eduction of ceric sulphate in air-saturated 0·4M uric acid solution, determined by comparison the ferrous sulphate yield was 2·52 ± 0·05 ceric reduced per 100 eV absorbed. The effects of al variables on these yields were investigated. A.

541.15

Irradiation of polymers by high-energy ons. E. J. LAWTON, A. M. BUECHE AND J. S. VII. Letter in *Nature* [*London*] **172,** 76–7 (*July* 11,).

easurements of solubility, swelling, gas evolution physical properties are reported for a large ber of polymers irradiated to upwards of 10^6 r electrons of peak energy 800 kV. The polymers nto two classes: those becoming cross-linked hose becoming degraded. In the cases of poly- ene, nylon and polydimethylsiloxane the obser- ns are recorded in detail. C. B. ALLSOPP

ERSIONS . COLLOIDS . ADSORPTION 541.18

541.182.4 : 532.12/.13

. The elastic and viscous properties of emulsions uspensions. J. G. OLDROYD. *Proc. Roy. Soc. A,* 122–32 (*June* 9, 1953).

calculation is made of the elastic properties of a e emulsion of one incompressible viscous liquid other, arising from the interfacial tension between wo phases. A linear relation between the stress r, the rate-of-strain tensor and their first time atives defines the behaviour at small rates of ; the three constants involved are expressed as ions of the viscosities of the two components, rop size (assumed small and uniform), the inter- l tension and the concentration. The relaxation and retardation time for the system vary directly e drop diameter and inversely as the interfacial on. The effect of slip at the interfaces, which t be associated with the presence of a film of a component introduced as a stabilizer, is also lated. The values of the rheological constants appreciably altered if the frictional coefficient fying the degree of slipping is sufficiently small, he type of elastic behaviour is unchanged. In ase of a suspension of elastic solid particles in a us liquid, slip at the solid-liquid interfaces can a change in the type of elastic behaviour. A.

541.183 : 537.533

Investigation of the surface reaction of oxygen carbon on tungsten with the field emission micro- . R. KLEIN. *J. chem. Phys.,* **21,** 1177–80 1953).

e adsorption of oxygen and carbon on tungsten he surface reaction between carbon and oxygen ngsten have been studied by means of the field ion microscope. Emission patterns for oxygen ngsten, carbon on tungsten, and oxygen and n together on tungsten under a variety of tem- ure pretreatment conditions have been obtained. age work functions over all exposed crystallo- ic planes, calculated from measured voltages and emission currents on the basis of the Fowler–Nordheim equation, give a measure of surface coverage in the case of oxygen on tungsten. The similarity of the emission-pattern changes in the evaporation of oxygen from tungsten with those found in the reaction between carbon and oxygen on tungsten suggests that the rate-controlling step in the reaction is desorption of oxygen from the tungsten surface. Diffusion of carbon into the tungsten lattice plays no role in the pattern changes since, in the absence of oxygen, the carbon-on-tungsten surface is found to be very stable. A.

CHEMICAL STRUCTURE 541.2/.6

541.51 : 539.132

The molecular orbital theory of chemical valency. *See Abstr.* 7012–13

541.57

7257. The charge on combining hydrogen atoms. R. T. SANDERSON. Letter in *J. chem. Phys.,* **21,** 1112–13 (*June,* 1953).

An extension of Abstr. 5183 (1953) in which the partial charges are now determined for the individual atoms of a number of hydrogen containing compounds. The hydrogen bridge bond and the hydrogen bond are compared in terms of the partial charge carried by the hydrogen atom and certain rules are obtained relating the stability of molecular systems to this partial charge. H. H. GREENWOOD

541.632

7258. Rotational isomerism in chloroacetone. S.-I. MIZUSHIMA, T. SHIMANOUCHI, T. MIYAZAWA, I. ICHISHIMA, K. KURATANI, I. NAKAGAWA AND N. SHIDO. *J. chem. Phys.,* **21,** 815–18 (*May,* 1953).

Raman spectra of chloroacetone were measured in the liquid and solid states and in solutions. Infrared absorption spectra of this substance were measured in the gaseous, liquid and solid states and in solutions. The temperature dependence of the intensity of the Raman lines and of the absorption bands were measured in the liquid state. From the experimental results together with the dipole data it was concluded that chloroacetone exists in two molecular forms in the liquid and gaseous states and in one form in the solid state. The less stable form in the liquid state becomes much more abundant than the other form in the gaseous state. Some considerations on the nature of hindering potential of internal rotation have been made. A.

541.64 : 539.133

7259. Molecular size distribution in the copolymerization of N-carboxyamino acid anhydrides. L. GOLD. *J. chem. Phys.,* **21,** 1190–2 (*July,* 1953).

The theory of molecular size distributions which are intrinsically Poisson in character is extended to cover two complementary aspects of copolymerization which are specifically adapted to polypeptide synthesis via the N-carboxyamino acid anhydride (Leuchs monomer). The statistical aspects for, (1) discrete monomer reacting with a Poisson-ensemble of initiators and (2) the circumstance of an array of monomers copolymerized by a discrete initiator are

delineated. Explicit relations for the number and weight average molecular weights are derived. A.

541.64 : 539.32

The effect of cross-linking on the elastic modulus of polythene. *See Abstr.* 7211

541.66

7260. On the temperature of fusion of polythenes. J.-F. JOLIET. *C.R. Acad. Sci.* [*Paris*] **236,** 1776–8 (*May* 4, 1953) *In French.*

Results are quoted to show that at the temperature of fusion the difference of the molar volumes of the compounds C_n and C_{n+2} tends rapidly to a constant value as n increases. The common limit of the temperature of fusion may be obtained from the formula $t_f = (\rho_0 - \rho_f) - dp/dt$ where ρ_f, the density at fusion, is obtained from the above observations, ρ_0 is the value at 0°C, and the limiting value, as n increases, of dp/dt is used. It is shown that the volume of the CH_2 group at fusion may be related to the dimensions for which rotation about the axis is possible amongst parallel chains. This suggests that, in general, the temperature of fusion of a linear polymer of n elements may be that for which the molar volume is n times the volume swept out by the rotation of a single element about the axis of the molecule.

H. H. GREENWOOD

541.67 : 538.222

7261. The magnetic susceptibility of certain organic compounds. IV. The constitution of *ortho*, *meta*, and *para* nitroanilines. H. MIKHAIL. *J. chem. Phys.*, **21,** 1004–6 (*June*, 1953).

Magnetic susceptibilities of *o*-, *m*- and *p*-nitroanilines have been measured by the Gouy method. The experimental results showed that for a strong repelling group such as the amino group, the values for the *op*-derivatives are lower than the corresponding *m*-derivative. This was attributed to the fact that there is a tendency for the amino group to conjugate with the benzene nucleus in the case of *o*-, and *p*-nitroanilines, accompanied by a lowering in their diamagnetic susceptibility values. A.

CHEMICAL PROCESSES 542.9

542.92

7262. A determination of the dissociation energies of mercury–carbon bonds by a pyrolytic method. B. G. GOWENLOCK, J. C. POLANYI AND E. WARHURST. *Proc. Roy. Soc. A*, **218,** 269–89 (*June* 25, 1953).

542.92

7263. The nature of mercury–carbon bonds in mercury alkyl radicals. B. G. GOWENLOCK, J. C. POLANYI AND E. WARHURST. *Proc. Roy. Soc. A*, **219,** 270–80 (*Aug.* 25, 1953).

542.921.2

7264. The mechanism of acetone pyrolysis. J. R. MCNESBY, T. W. DAVIS AND A. S. GORDON. Letter in *J. chem. Phys.*, **21,** 956 (*May*, 1953).

A study of the pyrolysis of 1 : 1 mixtures of normal and deutero-acetone at 400 mm pressure and 500°C. The acetones always exchanged, and the d_5/d_6 acetone ratio increased from 8 to 250% during a 40 min run. From a consideration of variation of the ratios of the different methane formed taken at different intervals during the s length of time, it is shown that the results are co patible with a Rice–Herzfeld free radical mechani H. H. GREENW

CHEMICAL ANALYSIS 543/545

543.712 : 539.18

7265. Measurement of moisture content by neu counting. J. SHARPE. *Brit. J. appl. Phys.*, **4,** 9 (*March*, 1953).

Unlike the method of Spinks, Lane and Torchin (1951), a $B^{10}F_3$ proportional counter was u A considerable gain in sensitivity and discrimina was obtained. At the optimum distance of source from the counter base (5 cm) the count was 8 times greater if 8% water was added to sand in which the equipment was immersed. F. R. H

545

7266. The measurement of low concentrations hydrogen in nitrogen. A. H. TURNBULL AND M. F HARRISON. *J. sci. Instrum.*, **30,** 266–8 (*Aug.*, 1953

Describes the development and construction Pirani gauge which incorporates a heated pallad "window," permitting only hydrogen to enter gauge. In conjunction with a cooled charcoal t the device has been successfully used to measure concentrations of hydrogen in nitrogen.

545.8 : 53

7267. A radioactive technique for the estimation tantalum in ferroniobiums and niobium miner A. KOHN. *C.R. Acad. Sci.* [*Paris*] **236,** 1419 (*April* 8, 1953) *In French.*

A technique previously described (A. Kohn, *Métall.*, **48,** 219–235 (1951)] was developed. Sam and standards were pile irradiated, and the long induced γ's detected. Samples containing betw 4·5 and 15·7 % Ta could be estimated with accuracy. F. R. H

545.

7268. Study of some mixtures of phosphates carbonates of calcium, natural or artificial, by me of their infrared absorption spectra. T. POBEGUIN J. LECOMTE. *C.R. Acad. Sci.* [*Paris*] **236,** 154 (*April* 20, 1953) *In French.*

Continuation of earlier work [see Abstr. 9 (1952)]. Using the region 6–15 μ, it is possible, comparison with synthetic mixtures, to estimate proportions of phosphate and amorphous crystalline carbonate in materials such as sea shells G. F. LOTH

545

7269. Identification of traces of samarium in presence of neodymium by fractional crystallization the octahydrated sulphates of Sm and Nd in a magn field. J. BLANDIN AND J. LORIERS. *C.R. Acad.* [*Paris*] **236,** 1885–7 (*May* 11, 1953) *In French.*

Crystals of $Nd_2(SO_4)_3 \cdot 8H_2O$ and $Sm_2(SO_4)_3 \cdot 8H$ are orientated in the magnetic field in the direction

eld and at right angles to the field, respectively. rvation of the direction of orientation with a)scope enables detection of 1% Sm sulphate to ade. G. I. W. LLEWELYN

545.844

Separation of AcB from AcC″ by paper natography. M. PEREY AND J.-P. ADLOFF. *C.R. Acad. Sci.* [*Paris*] **236**, 1664–6 (*April* 27, 1953) *In French.*

The chromatographic separation of AcC″ from AcB, noted in a previous paper [Abstr. 5190 (1953)] has been the object of detailed investigation. A method has been developed for a rapid preparation of AcC″ sources free from eluting agents or salts. F. LACHMAN

CRYSTALLOGRAPHY 548

548.0 : 531.743

An optical goniometer for the examination of netal single crystals. A. J. GOSS. *J. sci. Instrum.*, 83–5 (*Aug.*, 1953).

e mechanical construction and optical arrange- of the special form of goniometer is described. method of determination of the orientation from tching pit reflection patterns is briefly discussed practical information regarding etchants and allographic data is given in appendixes. A.

548.12 : 513.771

The so-called homology of crystals. A. V. NIKOV. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 3, 5 (1953) *In Russian.*

e symmetry elements can be reduced to transla- and mirror translation elements, and symmetry ations can be expressed in terms of linear ortho- l transformations of the type $x_i = c_{ij}x'_j$, where oefficients c_{ij} are direction cosines and $c_{ij}c_{ik} = 0$, $\neq k$, and 1, if $j = k$. Homology operations can scribed by the same type of transformation, but oefficients need not be direction cosines and the e relations between them are not all true. ology elements can be reduced to oblique tions in planes. While homology may be useful lescribing the purely geometrical properties of es and external forms, the homology of real als does not exist. Applications to crystals have based on an incorrect understanding of Fedorov's of limits, and deformation can only lower the metry of real crystals with physical properties. Abstr. 8420 (1951) and 7588 (1950). A. L. MACKAY

548.232.2

Further observations on the macromosaic ture of tin single crystals. E. TEGHTSOONIAN AND HALMERS. *Canad. J. Phys.*, **30**, 388–401 (*Sept.*,).

e Abstr. 1307 (1952). Further studies are ted on the bands, or striations, into which single als of high purity tin, grown by a modified man method, are partitioned. This striation ture is shown to exist throughout the whole ne of the crystal. The direction in which the daries of the striations form relative to the men axis is shown to be a compromise between al and crystallographic conditions, in which the tation of the (110) planes is the determining r. When new striations are formed, they are d to have an incubation period which is longer lower the rate of growth of the crystal. A tative mechanism is developed, based on the formation of dislocations into transition surfaces constituting the striation boundaries, which is consistent with all the experimental observations. A.

548.232.4

7274. Further observations on dendritic growth in metals. F. WEINBERG AND B. CHALMERS. *Canad. J. Phys.*, **30**, 488–502 (*Sept.*, 1952).

See Abstr. 1312 (1952). The direction of dendrite growth has been determined as a function of crystallographic orientation for high purity tin and zinc, using a single crystal decanting technique. Measurements are reported on the rate of dendrite growth in lead, and the spacing between dendrite rows of a lead crystal for varying amounts of supercooling. The initial formation of dendrite stalks appears related to a cell structure observed on the exposed solid liquid interface. A mechanism of dendrite growth is advanced and compared with the experimental observations. It is shown that dendritic growth occurs only during the initial part of solidification. The remainder is a result of the non-dendritic advance of a solid–liquid interface with some thickening of the existing branches. A.

548.4

7275. Dislocations and plastic flow in crystals. A. H. COTTRELL. *Oxford: Clarendon Press* (1953) 324 *pp.* [*International Series of Monographs on Physics*].

The purpose of this book is to bring together the various recent developments in the theory of dislocations and crystal plasticity into a single co-ordinated account. The first part describes the structures of dislocations and their geometrical and elastic properties, while in the later chapters the results of this theory are applied to numerous problems of crystal physics.

548.5

7276. Oriented overgrowth of platinum on muscovite. E. VOTAVA. Note in *Naturwissenschaften*, **40**, *No.* 10, 290–1 (1953).

The (111) plane of platinum fits to within 6% on the (001) plane of muscovite. The platinum crystals show varying orientations, probably indicating irregularities in the muscovite substrate. A. R. STOKES

548.5

7277. A simple method for the preparation of Al single crystals of given orientation. H. WEIK. *Z. angew. Phys.*, **5**, *No.* 3, 119–20 (1953) *In German.*

By bending and twisting at predetermined angles an Al-wire crystal, produced by the strain-anneal

method, can be converted into a crystal of the desired orientation. An apparatus for bending and twisting the wire is briefly described and illustrated. The accuracy of the method is stated to be 1–2 degrees.

S. WEINTROUB

548.5

7278. Growth of cadmium sulfide crystals. M. E. BISHOP AND S. H. LIEBSON. Letter in *J. appl. Phys.*, **24**, 660–1 (*May*); Erratum, 963 (*July*, 1953).

Two modifications of Frerichs' technique [Abstr. 3538 (1947)] for growing CdS crystals are briefly described. In the first, A replaces H_2 as the vehicular gas and passes at 1 cm/sec approx. over the molten Cd at 650°c. Best crystal growth occurred when a dense yellow fog of S appeared in the exhaust tube. The second method consists of passing A over molten CdS from one side and over molten S from the other side to combine within a quartz bulb. The reaction area is at 1000°c approx. The CdS crystals form inside the bulb and are 1 mm thick and several cm² in area. The gases used were at least 99·8% pure.

S. WEINTROUB

548.5

7279. Solute distribution in germanium crystals. W. P. SLICHTER AND E. D. KOLB. Letter in *Phys. Rev.*, **90**, 987–8 (*June* 1, 1953).

A number of Ge crystals were grown at various speeds and rates of crystal rotation, with Sb and Ga as solutes, by the method of Teal and Little. The rotation and thermal convection constituted the stirring of the melt. The variation with growth conditions of the distribution coefficient, defined as the ratio of the solute concentration in the solid to that in the bulk of the melt, was investigated and is shown graphically for both Sb and Ga in Ge. The importance of diffusion in the melt is pointed out and a theoretical expression for the distribution coefficient applicable to the steady state is given. S. WEINTROUB

548.5

7280. Macroscopic spirals and the dislocation theory of crystal growth. N. CABRERA. Letter in *J. chem. Phys.*, **21**, 1111–12 (*June*, 1953).

An explanation is suggested for the fact that macroscopic growth spirals associated with screw dislocations of very large Burgers vector, as for example on SiC crystals, remain multiple and do not decompose into elementary steps forming a spiral of many branches. A. D. LE CLAIRE

548.5 : 541.182.6

7281. On the growth of crystallites in nickel hydroxide sols. J. LONGUET-ESCARD AND J. MERING. *C.R. Acad. Sci.* [*Paris*] **236**, 1683–5 (*April* 27, 1953) *In French.*

See Abstr. 5876 (1951). Stable suspensions of $Ni(OH)_2$ in water were studied quantitatively by measuring the intensity of X-rays scattered by them. Monochromatic radiation was employed, with a focusing camera. It was found that the structure is characterized by the presence of small ordered domains separated by faults, and is analogous in some ways to the structure of graphite. The effect of ageing is studied in detail. J. THEWLIS

548.52 : 533

7282. The study of crystal growth with the elec microscope. III. Growth-step patterns and the relat ship of growth-step height to molecular structur *n*-nonatriacontane and in stearic acid. N. G. ANDER AND I. M. DAWSON. *Proc. Roy. Soc. A*, **218**, 255 (*June* 25, 1953).

For Pt II, see Abstr. 7671 (1952). The ex relationship between molecular association in solu and growth-step height was obtained from meas ments of shadowcast electron micrographs. Crys of the paraffin *n*-nonatriacontane, $C_{39}H_{80}$, give a va of growth-step height of 45 ± 10 Å, the unimolecu value. Similarly, crystals of stearic acid, $C_{17}H_{35}CO0$ give a value of 47 ± 10 Å, the bimolecular va There is thus strict correspondence between the u molecular nature of *n*-nonatriacontane molecules solution and unimolecular *n*-nonatriacontane grow steps, and between the bimolecular nature of ste acid molecules in solution and bimolecular ste acid growth-steps. In crystals of both compou grown from a dislocation of length any multiple the length of the units in solution, multimolecu growth-steps were not encountered. Instead, growth pattern dissociated into a succession of u molecular steps in *n*-nonatriacontane crystals bimolecular steps in stearic acid crystals. There thus strong evidence that the size of the uniti solution and not the length of the parent dislocat is the responsible factor in deciding the height growth-steps. The crystals examined show a var of growth-step patterns—spirals, layers, half-st and flat-tops. In layered crystals which show no s of spiral growth there is strong internal evidence t the crystals have in fact grown by a spiral mechani A series of micrographs showing crystals in a state transition makes it clear that the screw dislocat responsible for growth has been cancelled out by formation of an equal and opposite dislocati Numerous examples of this cancellation process h been encountered either at the end of all growth or a relapse when one of the dislocations in a pair of same sense has been cancelled during growth. T evidence for the growth and movement of dislocati in real crystals shows that crystals with molecula flat surfaces may well be produced by a mechani based on screw dislocations. The fact that no spi growth-steps can be observed is no longer adequ proof that a spiral growth mechanism did not produ the crystal in question.

548.52 : 535

7283. Interferometric studies of the growth of stea acid crystals and their optical properties. A. VERMA AND P. M. REYNOLDS. *Proc. Phys. S* [*London*] *B*, **66**, 414–20 (*May*); Erratum, 523 (*Ju* 1953).

On the basal planes of stearic acid crystals, gro from solution, growth spirals observed by optical a phase contrast microscopic techniques are report These growth spirals are in accordance with theory of Burton, Cabrera and Frank. For measurement of spiral step-heights multiple-bea interference methods were used, including a modifi multiple-beam interference method, which is describ The minimum step-height found was 46·3 ± 0·8

h agrees with the X-ray repeat unit. In addition, heights which were integral, as well as half integral, iples of this unit were found. By interferometric ods the refractive index was found to be ± 0·04 and for the two types of crystal rhomb rved the birefringence for directions of vibration llel to the "a" and "b" axes was approximately 8 and 0·015 respectively for $\lambda = 5461$ Å. A.

548.538 : 539.23

rystal growth and orientation in deposits condensed n the vapour. *See Abstr.* 7198

548.55 : 536.212.2

l. Heat flow and the growth of metal single tals from the melt. A. J. Goss. *Proc. Phys. Soc. don] B*, **66**, 525–32 (*July*, 1953).

simple theoretical relation is derived for the flow in a crystallizing metal rod and three cases esponding to slow, medium (≃5 mm min^{-1}), and rates of growth, are considered. Details are n of temperature-time traces obtained experi- itally using a thermocouple embedded in the lifying metals, viz. Bi, Cd, In, Pb, Sn and Zn. shapes of the traces are of three types correspond- to the three cases considered theoretically. It is wn that an approximate value of the ratio of the mal conductivities of the solid and liquid metal be obtained from the experimental results for the v rate of growth, and values of the ratio are given the six metals used. The importance of the heat on the form and orientation of the crystals is ussed. A.

548.572

5. Surface structures on evaporation of single tals of alkali halides. E. Kern and H. Pick. *hys.*, **134**, *No.* 5, 610–17 (1953) *In German.*

hree different laminar structures appear: "right led laminae" up to within 50°c of the m.p., a agonal transition structure," and "circular laminae" r the m.p. The thickness of the layers of all three 0^{-3} to 10^{-4} mm. A number of plates show the ct for KCl and KBr. C. TURNER

548.574 : 535.417

6. Microscopic and interferometric observations corrosion figures and their interpretation in terms of ocations. R. Gevers. *J. Chim. phys.*, **50**, 321–8 *ay*, 1953) *In French.*

xperiments were conducted with crystals of topaz l of carborundum, the interferometric observations ng carried out by the Tolansky method (1948). was proved conclusively that screw dislocations erging at the crystal surface give rise to corrosion ires of a special type formed by a process which is inverse of that proposed by Frank for the growth crystals. Deep polygonal shaped cavities with ply sloped sides appear, centred on the points of ergence of screw dislocations; along the length of ral growth steps, closely spaced but less pro- nced, and roughly circular pits are formed. Such ferential attack frequently reveals spiral growth os which were not previously visible. Many of the ailed features of these corrosion figures are cribed and illustrated, and discussed in terms of ocations. The deep pits occurring at the points of emergence of dislocations frequently occur along intersecting lines which are related in direction to the symmetry of the crystal face. Such regularity of arrangement is considered to be evidence for the existence of rows and perhaps of lattices of dislocation lines, as envisaged in contemporary dislocation theory. A. D. LE CLAIRE

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 535.345.2

Absorption bands and lines in irradiated LiF. *See Abstr.* 6646

548.7 : 538.566 : 535.135

Propagation of electromagnetic waves through a crystal plate. *See Abstr.* 6576

548.7 : 538.566 : 535.135

Propagation of X-rays through a crystal plate. *See Abstr.* 6577

548.7 : 538.566 : 535.135

The propagation of light waves through a crystal plate. *See Abstr.* 6578

548.7 : 539.219.2

7287. On the lattice expansion of crystals by added atoms. J. Teltow. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 111–20 (1953) *In German.*

The change in the mean lattice parameter as obtained by X-ray diffraction and the change in volume are calculated, and are found to agree: this contradicts the results of Miller and Russell [Abstr. 535 (1953)]. A. R. STOKES

548.7 : 539.219.2

7288. Effect of internal strains on linear expansion, X-ray lattice constant, and density of crystals. C. R. Berry. Letter in *J. appl. Phys.*, **24**, 658–9 (*May*, 1953).

Three examples are quoted where the X-ray and the directly measured changes in density on forming solid solutions are nearly equal, contrary to recent theoretical predictions [Abstr. 535 (1953)] that there may be an appreciable difference between the two, arising from strains associated with solute atoms or defects. A. D. LE CLAIRE

548.7 : 539.153

7289. Vibrational modifications of the electron distribution in molecular crystals. I. The density in a vibrating carbon atom. P. W. Higgs. *Acta cryst.*, **6**, 232–41 (*March*, 1953).

The electron density derived from measurements of the Laue scattering of X-rays by a crystal is shown to be the density in the stationary crystal averaged over all possible displaced configurations of the atomic nuclei in thermal equilibrium together at the temperature of the experiment. The calculation of the mean electron distribution falls into two parts: in general the mean density in an atom is a function of the tensor formed by the mean square amplitudes and mean products of amplitudes of the atomic motion; for a particular crystal this tensor has to be calculated from the force constants and geometry. In the present paper the mean density in a carbon atom is

computed as a function of the r.m.s. amplitude of isotropic thermal motion. It is found that quite a small amplitude suffices to reduce the peak density considerably below the value in a stationary atom; on the other hand, the bridge density in a bond between two atoms is increased. At the amplitudes which occur in many molecular crystals at ordinary temperatures the distribution in an atom is nearly gaussian. A.

548.7

7290. Ionic movements in crystals. II. A. SEEGER. *Z. Naturforsch.*, **8a**, 246–8 (*April*, 1953) *In German.*

Solutions with standing waves of the formula in Pt I [Abstr. 3722 (1953)], for the Frenkel model are given, proving that there can be standing ionic movements for non-linear forces. C. TURNER

548.7

7291. The deuterium effect on hydrogen bond distances in crystals. R. E. RUNDLE. Letter in *J. chem. Phys.*, **21**, 937–8 (*May*, 1953).

Nordman and Lipscombs' [Abstr. 1321 (1952)] suggestion that this effect is due to the broad, nearly square-well, potential energy field for hydrogen in a strong hydrogen bond seems to be supported by Megaw's data on ice [*Nature* [*London*] **134**, 900 (1934)] which show a temperature effect. More experiments are needed. C. TURNER

548.7

7292. Quantum theory of the polarizability of an idealized crystal. D. L. DEXTER AND W. R. HELLER. *Phys. Rev.*, **91**, 273–8 (*July* 15, 1953).

The quantum mechanical polarizability of an idealized insulating crystal is calculated by the semi-classical method, in which the electromagnetic radiation of frequency small compared with electronic resonance absorption frequencies is treated classically. A generalization of the Lorentz "internal field" effect emerges naturally from the treatment. Correction terms to the Lorentz value for the polarization of a crystal, $n_0[\alpha_a/(1 - 4\pi n_0\alpha_a/3)]\epsilon$, where α_a is the polarizability of an isolated atom, n_0 the density of atoms and ϵ the applied field, arise from three main sources: (1) exchange and overlap effects, (2) higher order terms in the atomic interactions than dipole-dipole terms and (3) second and higher powers of the small parameter $4\pi n_0\alpha_a/3$. These correction terms, which are shown to be important in real crystals, are briefly discussed, although more must be known about specific wave functions in order to make quantitative calculations. The connection is pointed out between the propagation of excitons and the Lorentz effect. A.

548.7

7293. On the disorder in crystalline 2,2-dinitropropane at room temperature. S. C. ABRAHAMS. *J. chem. Phys.*, **21**, 1218–19 (*July*, 1953).

2,2-dinitropropane forms face-centred cubic crystals at room temperature, with $a_0 = 8{\cdot}78 \pm 0{\cdot}05$ Å, and 4 molecules per unit cell. Molecular disorder is necessarily present in the cell, and several models are examined. Excellent agreement is obtained with a model in which the molecule possesses complete orientational disorder. Although the distinction between "rotational" disorder in time and in space is not possible, the following mechanism is sugges while the disorder is complete at long range, there high degree of order at short range.

5

7294. The study of order-disorder changes. Short range order in the alloy $AuCu_3$. G. FOUR *J. Phys. Radium*, **14**, 226–34 (*April*, 1953) *In Frenc*

For Pt II, see Abstr. 9155 (1952)]. Yvon's th (1945) is applied to calculate, for temperatures ab the critical temperature, the short-range order pa meters for the 1st to the 8th nearest neighbours of one atom; from these the relative intensities diffusely scattered X-rays, which depend on the sh range order, are computed for points in the 100 pl of the reciprocal lattice, and the results presen graphically. The calculations are in good agreem with the experimental measurements of Cow [Abstr. 2782 (1950)] if for W_1 and W_2, the interact potentials between 1st and between 2nd nea neighbours, the values chosen are $W_1 = 1{\cdot}1$ 10^{-13} ergs and $W_2/W_1 = -0{\cdot}5$. These values of and W_2 are in good accord with those deduced fr a study (in press) of long-range order in the same all

A. D. LE CLA

548.7 : 535.343 : 535.377 :

7295. Coloration and luminescence. [Verfärbu und Lumineszenz]. K. PRZIBRAM. *Vienna, Spring Verlag* (1953) *xiii* + 275 *pp. In German.* [*Con butions to mineral physics*—Beiträge zur Mine Physik].

The book collects together for the first time all researches in its subject in a well-arranged sequen including the many original publications of author's research school. Pt I gives a brief survey earlier work and the geological significance of subject and then deals with the techniques of colo tion of crystals by particles, radiation, vapour tre ment and chemical reaction. Following this a la section is devoted to experimental work on the alk halides, theoretical discussion of the formation colour centres and their nature, photoelectric effec coloration in glasses by colloid formation a luminescence characteristics of the materials studie Pt II is concerned with coloration in natural minera particularly rock salt and fluorite. Further sectio consider other minerals including oxides, sulphid carbonates, sulphates, nitrates, phosphates, silicat and diamond. A final chapter is devoted to pleochrc haloes in minerals and their physical and geologic significance. Full references are given to current a past literature on the subject. G. F. J. GARLIC

548.7 : 535.34

7296. Absorption of light by trapped electron R. C. O'ROURKE. *Phys. Rev.*, **91**, 265–70 (*July* 1 1953).

A new method of approach to the problem absorption of light by trapped electrons in crystals presented. The method is based upon the use of th Slater sum for an oscillator (density matrix). Th absorption cross-section is calculated under th assumption of an electron-lattice coupling which linear in the normal co-ordinates of the lattice; thi yields the shape of the absorption curve, but th maximum does not shift with temperature as require

xperiment. This shift is then accounted for in a ewhat fundamental manner by considering the l change in the lattice frequencies which accom- es the photon induced electronic transition. The lt is that the absorption maximum shifts with perature, but the shape of the absorption curve is affected by the change in the lattice frequencies. A.

548.7

7. Dislocation nodes in face-centred cubic lattices. THOMPSON. *Proc. Phys. Soc.* [*London*] *B*, **66**, 481–*June*, 1953).

wo or more dislocation lines meeting at a point stitute a node. In face-centred cubic lattices a location can split into two partial dislocations. The irements of crystal geometry impose certain tations on the arrangement of partial dislocations node. The various possibilities are discussed. s shown that some nodes are fixed relative to the ice, while others can move by glide processes in ain crystallographic directions. The length of location line joining two nodes can function as a nk–Read source. The effect of the node structure the behaviour of the source is considered, and it is wn that such a source may progressively change character during the process of dislocation duction. A.

548.7

8. Space-charge layer and distribution of lattice ects at the surface of ionic crystals. K. LEHOVEC. *hem. Phys.*, **21**, 1123–8 (*July*, 1953).

t is shown that an electric potential exists between surface and the bulk of ionic crystals. The ential is expressed in terms of the energies necessary formation of lattice defects. The distribution of potential and of lattice defects near the surface is culated. The difference between the concentration attice defects near the surface and that in the bulk ds to a "surface conduction." The magnitude of potential, the thickness of the space-charge layer r the surface and the "surface conduction" are culated for NaCl crystals using numerical values, culated by Mott and Littleton (1938) for the rgies of formation of lattice defects. The effect of rged impurities in the crystals on the surface ential is discussed. The importance of the surface ential on diffusion, photoelectric effect and photo- phic effect is mentioned. A.

548.73

9. International tables for X-ray crystallography. P. EWALD. *Birmingham: Kynoch Press* (1952) + 558 *pp.*

Review in *Nature* [*London*] **171**, 944–6 (May 30, 53).

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See str.* 7201–5

548.732

0. Intensity of X-rays scattered by thermal tation of atoms. J. LAVAL. *C.R. Acad. Sci.* [*Paris*] 5, 1765–7 (*May* 4, 1953) *In French.*

The thermal scattering may be represented by a hly convergent series, in which the *n*th term resents the intensity due to the electron density oscillations caused by the thermal motions of any *n* atoms taken together. A. R. STOKES

548.732

7301. X-ray transmission studies of large imperfect crystals. G. L. ROGOSA AND G. SCHWARZ. Letter in *J. appl. Phys.*, **24**, 954–6 (*July*, 1953).

See Abstr. 8565 (1952). Geiger-counter records are given showing transmission and reflection near the Bragg angle for thin, medium and thick crystals of LiF, showing respectively extinction, asymmetric transmission and anomalous transmission. A. R. STOKES

548.732 : 537.531 : 535.34

7302. The transmission and absorption of X-rays in calcite near the Bragg angle. G. BROGREN AND O. ADELL. *Ark. Fys.*, **7**, *Paper* 1, 1–5 (1953).

A two-crystal spectrometer with two Geiger-counters (for transmitted and reflected beams) was used. Intensity curves are given for five wavelengths from 0·7 to 1·8 Å, for the (211) planes of calcite. Results agree with theory of Hirsch [Abstr. 5437 (1952)] and Ramachandran [Abstr. 5439 (1952)]. A. R. STOKES

548.733

7303. Aluminium monochromator with double curvature for high-intensity X-ray powder photographs. G. HÄGG AND N. KARLSSON. *Acta cryst.*, **6**, 728–30 (*Nov.*, 1952).

The construction and performance of an X-ray monochromator using an aluminium single crystal with double curvature is described. The point-focus obtained in this way is used for taking powder photographs of the Guinier type. The gain in intensity is about 16× as compared with a monochromator using a quartz crystal with single curvature and polished surface, all other conditions being equal. A.

548.733

7304. A precision back-reflexion microbeam X-ray camera with provision for pre-selecting the irradiated area. R. W. CAHN. *J. sci. Instrum.*, **30**, 201–4 (*June*, 1953).

A camera is described which allows the orientations of pre-selected individual grains in an aggregate to be accurately determined. A pinhole in a metal foil mounted next to the specimen is used as a reference point, through which the X-ray beam is sent by taking readings from an electronic counter placed behind the foil. The principles of X-ray collimation are discussed. A.

548.733

7305. An X-ray camera for measuring preferred orientation in wires. A. L. MACKAY. *J. sci. Instrum.*, **30**, 244–5 (*July*, 1953).

A collimated X-ray beam has been arranged to pass along the axis of a cylindrical film cassette. The wire specimen under examination crosses the beam at right angles, running right through the camera, and being moved by a motor so that a 3 cm length is scanned. From a special chart the degree of orientation of each reflecting plane can be read directly. The camera combines the advantages, for orientation determination, of the flat plate camera and the normal powder camera. A. L. MACKAY

548.733

7306. Measurement of X-ray intensities on integrated Weissenberg-photographs. D. W. Smits and E. H. Wiebenga. *J. sci. Instrum.*, **30**, 280–1 (*Aug.*, 1953).

A simple photometer for the measurement of X-ray intensities on integrated Weissenberg photographs is described. Conditions are given for sufficiently homogeneous development of the film. A.

548.733 : 621.386.8

7307. A highly stable automatic X-ray diffraction apparatus with only one moving part. C. K. Jones. *Rev. sci. Instrum.*, **24**, 380–7 (*May*, 1953).

Modifications are described which have been added to existing automatic X-ray diffraction apparatus. These were added in an effort to obtain accurate and reproducible data of the intensities of X-ray diffraction patterns. The modifications consisted of: (*a*) the addition of an ionization gauge whose purpose was to keep constant the intensity of the incident beam irradiating a sample and (*b*) the use of a so-called "square wave method" of counting. It has been shown that with these two modifications it was possible to produce records of X-ray diffraction patterns of a powdered crystal which can be duplicated time after time within the limit of errors introduced by the statistical arrival of the diffracted quanta. A.

548.734

7308. The measurement of X-ray line breadths. T. R. Anantharaman and J. W. Christian. *Brit. J. appl. Phys.*, **4**, 155–6 (*May*, 1953).

Simple analytical methods for finding the position of the α_1 peak and the integral breadth of the α_1 component of a composite Debye–Scherrer powder line are described. The expressions are exact for symmetrical lines, and sufficiently accurate for very broad asymmetrical lines. The problem of correct location of the background level is also considered. A.

548.734.3

7309. A graphical method for the determination of the unit-cell dimensions of non-cubic materials from X-ray powder photographs. J. Thewlis. *Acta cryst.*, **6**, 849–50 (*Nov.*, 1952).

548.735

7310. Proof of the existence of an unambiguous Röntgen structure analysis by "folding" [Entfaltung]. I. Folding of centrosymmetrical finite mass distributions. V. R. Hosemann and S. N. Bagchi. *Acta cryst.*, **6**, 749–62 (*Nov.*, 1952) *In German.*

With the help of the folding (*Faltung*) theorem of Fourier transformation a proof is given that the electron-density distribution in matter of finite size and having a centre of symmetry (or antisymmetry) can be calculated from the X-ray diffraction data alone. For this the fine structure of reflections, i.e. the general distribution of the scattered intensity in Fourier space and not the integral intensities of reflections only, must be known. After elimination of Thomson and polarization factors as well as collimation and other relevant experimental errors, the corrected intensity is transformed through inverse Fourier transformation to the so-called *Q*-function of physical space. This continuous *Q*-function is then transformed into a lattice-peak-function ha sufficiently small cell dimensions (*Rasterung Q-Funktion*). From this "latticed" *Q*-function required electron-density distribution can be obtai through a folding (*Faltung*) polynomial of fi degree. The electron-density distribution is obtai automatically as a lattice-peak-function having same cell as that of the *Q*-function. This proc gives the solution of an integral equation of second degree from any one of its boundary val For the limiting case of infinitely small cells of lattice, the folding polynomial of infinite degree Fourier space reduces to a special polynomial degree ½, which is identical with the Fourier transfo of the required continuous electron-density distri tion. This proves the inherent consistency of method. It is to be noted that for matter of infi size, such a method of evaluation of necessity f since the *Q*-function is then infinitely extended consequently has no boundary values.

548.

7311. An orthogonal unit vector triplet associa with a general lattice. A. L. Patterson. *Acta cry* **6**, 829–33 (*Nov.*, 1952).

It is shown that there exists an orthogonal u vector system **E** and a symmetric matrix γ (togeth with its inverse γ^*) such that the four expressio $\mathbf{a} = \gamma\mathbf{E}$; $\mathbf{E} = \gamma\mathbf{a}^*$; $\mathbf{a}^* = \gamma^*\mathbf{E}$; $\mathbf{E} = \gamma^*\mathbf{a}$ give transformations between the systems **a**, **a*** and The γ-matrices are then defined by the mat equations $\gamma^2 = \mathbf{g}$ and $\gamma^{*2} = \mathbf{g}^*$. The solutions a given explicitly for all two-dimensional nets and all symmetrical three-dimensional lattices. Metho are suggested for the numerical calculation for t triclinic lattice. Uses for the E-systems in crys calculations are also discussed.

548.7

7312. Corrections to Grison's paper on the Harke Kasper inequalities and to Zachariasen's paper on t "statistical method." L. R. Lavine. *Acta cryst.*, , 846–7 (*Nov.*, 1952).

See Abstr. 1332, 4765 (1952).

548.7

7313. The effect of vertical divergence on X-ra powder diffraction lines. L. Alexander; J. Eastabrook. Letters in *Brit. J. appl. Phys.*, **4**, 92 (*March*, 1953).

A discussion of the relative merits of Alexande treatment [Abstr. 1053 (1949), 2493 (1950)] an Eastabrook's treatment [Abstr. 541 (1953)].

A. R. STOKE

548.73

7314. A new application of EDSAC to cryst structure analysis. W. Cochran and A. S. Dougla Letter in *Nature* [*London*] **171**, 1112–13 (*June* 20, 1953

The computer EDSAC is used to calculate "plausibility" function $\sum_{\mathbf{h}}\sum_{\mathbf{h}'} U(\mathbf{h})U(\mathbf{h}')U(\mathbf{h}+\mathbf{h}')$ [Abst 4763 (1952)] for every combination of signs of th *F*'s of the strongest reflections. The most likel combinations can then be picked out for trial Fourie syntheses of electron density. The system wa successfully tried on salicyclic acid. A. R. STOKE

548.735 : 518.5

R-PAC: analog recorder-playback computer ystal analysis. R. PEPINSKY AND P. JARMOTZ. in *J. appl. Phys.*, **24**, 663–4 (*May*, 1953).

Patterson function from the computer X-RAC epinsky: *Computing methods and the phase m in X-ray crystal analysis* (X-ray crystal is laboratory, Pennsylvania State College, is recorded photographically on a cylindrical and is played back by illuminating from within eceiving signals on several photoelectric cells le the cylinder. Any one of Buerger's image- g functions [Abstr. 1334 (1952)] can be obtained tably placing the photoelectric cells and suitably ning their outputs. A. R. STOKES

548.735 : 535.42

The application of the principles of physical to crystal-structure determination. A. W. ON, H. LIPSON AND C. A. TAYLOR. *Proc. Roy.* 1, **218**, 371–84 (*July* 7, 1953).

analogy between the diffraction of light by a holes, and the diffraction of X-rays by a set of can be exploited in solving many different of X-ray diffraction problem. A special instru- has been built to obtain diffraction patterns y, making possible several different approaches e determination of crystal structures. Of ular importance is that involving the "optical orm" of a molecular representation. Considera- f the optical transform, which is closely related e Fourier transform, can, for simple space s, lead directly to the crystal structure. For complicated space groups, optical transforms olecules in different orientations have to be ined, and some rules governing their combina- are given. The discussion includes several ples of structures which have been determined tical-transform methods. These methods require esentation of the X-ray data in the form of a ted reciprocal lattice, from which information often be obtained directly. For several new ures such information as the separation of two rly oriented molecules, or the orientation of onal arrangements of atoms, has been deduced nsidering the weighted reciprocal lattice alone. ne cases this led to the complete structure; in it was a valuable supplement to the optical orm method. Despite the lack of quantitative acy, optical methods can be of use in refining ximate structures by ordinary Fourier methods. ples are given of the determination of the e phase angles of the reflections of both centro- etric and non-centrosymmetric structures. The nships between optical methods and more ntional methods of structure determination are sed. A.

548.735 : 535.42

The optical derivation of structure amplitudes. HANSON. *Acta cryst.*, **6**, 35–6 (*Jan.*, 1953).

548.735.44

Fourier representation of Buerger's image- g minimum function. W. J. TAYLOR. Letter in *l. Phys.*, **24**, 662–3 (*May*, 1953).

548.735.44

7319. Fourier synthesis of crystals and its application in chemistry. [Fouriersynthese von Kristallen und ihre Anwendung in der Chemie]. W. NOWACKI. *Basle: Birkhäuser* (1952) 237 *pp.* (*Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, Chemische Reihe, Band* 6).

Review in *Nature* [*London*] **171**, 1131–2 (*June* 27, 1953).

548.735.7

7320. X-ray study of the dimensions of the reflecting regions [domaines de Bragg] in polycrystalline powders. II. Application to the study of the texture and structure of pyrophoric iron powders and of their magnetic properties. E.-F. BERTAUT. *Bull. Soc. Franç. Minéral. Crist.*, **76**, 1–58 (*Jan.–March*, 1953) *In French.*

For Pt I, see Abstr. 2821 (1953). An X-ray study of the preparation of pyrophoric iron powders by decomposition of iron formate, and of the properties of iron powders so formed. Particle size was measured by X-ray methods and surface area by physical chemical methods. The coercive force of such powders shows a maximum value of about 1000 oersteds for a particle size of about 200 Å, and it is concluded that this large coercive force is due to geometrical factors such as shape and size of the particles rather than to internal stresses. A. E. DE BARR

548.736.1

7321. Precision investigations on the zinc lattice. I. Precision measurement of lattice constants and investigations on lattice distortions. B. ANCKER. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 121–44 (1953) *In German.*

Use is made of the compensation method of measurement due to Kossel and to van Bergen. The mean error is claimed to be about 1 part in 130 000 with $a_0 = 2{\cdot}66469$ Å and $c_0 = 4{\cdot}94616$ Å at 22·00°c. The results suggest that the accuracy claimed is not absolute, but represents the accuracy of repetition on the same specimen. The method is employed to study lattice distortion, and measurements are made of the maximum deviations from the normal lattice parameters that are possible without the production of recognizable domains. The mosaic structure of zinc crystals is studied and it is shown that an expanded lattice, free from distortion, may be obtained following the introduction of foreign atoms. J. THEWLIS

548.736.1

7322. Precision investigations on the zinc lattice. II. On the production of twins. B. ANCKER. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 145–54 (1953) *In German.*

By the use of the compensation method (see preceding abstract) it is concluded that in the neighbourhood of spontaneously produced twinning lamellae the mother crystal is undistorted at one boundary and has a mosaic structure at the other. The view of Burke and Hibbard [*Trans Amer. Inst. Min. Metall. Engrs, Metals Division*, **295** (1952)], that the occurrence of twinning is always associated with a bending of the basal plane, is not correct. J. THEWLIS

548.736.3

7323. On the electron density distribution in the rocksalt lattice. M. RENNINGER. *Acta cryst.*, **6**, 711–22 (*Nov.*, 1952) *In German.*

Experiments on the absolute intensity of X-ray

reflections from rocksalt at room temperature and at 20°K have given the following results: (1) The observed F curves lie higher than those previously measured. The difference increases with increasing order of reflection and at $1/d = 2 \sin\theta/\lambda = 2$ exceeds 20% in F (i.e. 40% in intensity) for the (Cl + Na) reflections. On the (not strictly correct) assumption of a common temperature factor for the whole lattice the observations lead to a characteristic temperature for rocksalt of 320°K compared with the previously accepted value of 281°K. Treating the two types of ions separately gives temperature factors with B parameters $1{\cdot}12\times10^{-16}$ cm^2 for Cl^- and $1{\cdot}25\times10^{-16}$ cm^2 for Na^+ at 290°K, and $0{\cdot}32\times10^{-16}$ for Cl^- and $0{\cdot}60\times10^{-16}$ cm^2 for Na^+ at 20°K. (2) The intensities (and F values) lie on smooth curves when plotted against $1/d$. Within the accuracy of the measurements there is no evidence of any departure from spherical symmetry in the charge distribution of the ions, and therefore no evidence of any accumulation of charge in the lattice. (3) The observed F curves, assuming the above temperature factors, agree remarkably well with the F curves of Hartree for Cl^- and Na^+. In the case of Cl^- they confirm the more recent calculations of Hartree taking account of the influence of electron exchange according to Fock and Petrashen, in that they agree better with the new charge distribution than with the old. Small outstanding systematic discrepancies in the results at low temperatures are discussed and are applied to calculate possible departures from the theoretical charge distribution. A.

548.736.3

7324. Crystalline forms of UO_3. P. Perio. *Bull. Soc. Chim. France*, **20**, *No.* 7–8, 776–7 (1953) *In French.*

Two forms obtained by vacuum heat-treatment have respectively an orthorhombic unit cell, $a = 12{\cdot}98$, $b = 10{\cdot}70$, $c = 7{\cdot}49$ kX and a tetragonal unit cell, $a = 5{\cdot}10$, $c = 6{\cdot}82$ kX. A. R. STOKES

548.736.3

7325. X-ray diffraction study of the absorption of deuterium by lanthanum. B. Dreyfus-Alain. *C.R. Acad. Sci.* [*Paris*] **236**, 1265–6 (*March* 23, 1953) *In French.*

Absorption of deuterium at 250°C gives rise to two cubic structures, one of which disappears on further treatment. The reactions are not reversible.

A. R. STOKES

548.736.3 : 536.413 : 536.631 : 537.311.33 : 538.222

Study of the development of some properties of vanadium oxide in the neighbourhood of its transformation temperatures. *See Abstr.* 6951

548.736.3 : 537.226.2

Origin of ferroelectricity in barium titanate and other perovskite-type crystals. *See Abstr.* 6757

548.736.3 : 538.222

Lattice constants and magnetic susceptibilities of solid solutions of uranium and thorium dioxide. *See Abstr.* 6953

548.736.4

7326. Superlattice studies in the systems silver–magnesium–tin and silver–magnesium–zinc. W. G. Henry and G. V. Raynor. *Canad. J. Phys.* 412–21 (*Sept.*, 1952).

The 3/2 electron compound in the system Ag in which tin and zinc are soluble, has an ord structure of the cesium chloride type (second superlattice). The first additions of tin to this do not affect the ordered structure. Above a ce limit, a third zone superlattice is formed, and th atoms themselves occupy ordered positions. examination at high temperatures shows that third zone superlattice disorders independently c main, second zone superlattice. The transform temperature increases with increasing tin con that of the cesium chloride superlattice, how decreases with increasing tin content. In the Ag–Zn, the introduction of zinc into the binary Ag 3/2 electron compound causes no development third zone superlattice. The temperature at w the second zone superlattice disorders decreases increasing zinc content. It is suggested that reason for the existence of the second superla depends upon a combination of the following fac (i) The lattice distortion due to the high valenc tin creates a long-range distortion which is easily distributed, leading to a minimum intera strain energy, by the formation of a doubly ord structure. (ii) The electrochemical effect bet magnesium and tin atoms at a distance "a" (where "a" is the lattice spacing of the body-cen cubic cell) contributes to the lowered free energy doubly ordered structure.

548.736.4 : 539

7327. The crystal structure of nickel carbo $Ni(CO)_4$. J. Ladell, B. Post and I. Fankuc *Acta cryst.*, **6**, 795–800 (*Nov*,, 1952).

The crystal structure of nickel carbonyl has determined. Single-crystal oscillation diagrams been obtained at -55 ± 5°C. These have indexed on the basis of a cubic unit cell with $10{\cdot}84 \pm 0{\cdot}02$ Å. There are 8 molecules per unit The most probable space group is $Pa3$. Elect density projections indicate that the configuratio the molecule is that of a regular tetrahedron. analysis of one- and two-dimensional section three-dimensional Fourier syntheses indicates following bond lengths: Ni–C = $1{\cdot}84 \pm 0{\cdot}03$ Å, Ni–O = $2{\cdot}99 \pm 0{\cdot}03$ Å. These are in good ag ment with known values determined by mean electron diffraction. The calculation of the elec density along a cube diagonal indicates that the at arrangement is Ni–C–O and not the alterna possibility Ni–O–C.

548.736.4 : 539

7328. The crystal structure of phosgene, CC B. Zaslow, M. Atoji and W. N. Lipscomb. *cryst.*, **6**, 833–7 (*Nov.* 10, 1952).

The crystal structure of phosgene is tetrag C_{2h}^5–$I4_1/a$ with 16 phosgene molecules in a unit of dimensions $a = b = 15{\cdot}82$, $c = 5{\cdot}72$ Å. -160°C, the crystal is completely ordered, and residual entropy of 1·63 e.u. remains unexplai Parameters, referred to a centre of symmetry as or are for Cl_1 (0·0394, −0·1417, 0·150); for (0·1038, −0·0528, −0·250); for O (0·1982, −0·1 0·039); and for C (0·1295, −0·1126, −0·0

ular dimensions are $C–Cl_1 = 1·74 \pm 0·02$ Å, $= 1·74 \pm 0·02$ Å, $C = O = 1·15 \pm 0·02$ Å, $Cl_1–C–Cl_2 = 111·0 \pm 1·5°$. A.

548.736.5

The crystal structure of thiocyanates. VI. The l structure of complex tetrathiocyanates of zinc, um and mercury. Z. V. ZVONKOVA. *Zh. fiz.* , **26**, *No.* 12, 1798–803 (1952) *In Russian.*

Pt V, see Abstr. 6896 (1952). $K_2Zn(NCS)_4$. is orthorhombic, space group $P2_122_1$, with 1·11, $b = 5·41$, $c = 13·04$ Å; $Z = 2$, $\rho_{calc.} = \rho_{obs.} = 1·82$. It is isomorphous with $K_2Co(NCS)_4$. determined earlier [*Ibid.*, **24**, 1339 (1950), and *ek. Platiny Inst. Obshch. Neorg. Khim.*, **26**, 235]. $K_2Cd(SCN)_4.2H_2O$ is monoclinic, space $C2/c$, with $a = 12·96$, $b = 5·71$, $c = 18·85$ Å, 7° 30′; $Z = 4$, $\rho_{calc.} = 2·20$, $\rho_{obs.} = 2·16$. The c parameters (x, y, z) were found to be;

250, 0·250, 0)	N_I (0·360, 0·453, 0·063)
548, 0·378, 0·153)	N_{II} (0·304, 0·255, 0·175)
424, 0·000, 0·023)	C_I (0·387, 0·254, 0·045)
181, 0·102, 0·119)	C_{II} (0·250, 0·098, 0·150)
389, 0·177, 0·198)	no details of the analysis ven.

$Hg(SCN)_4$ is monoclinic, space group $C2/c$, with 1·04, $b = 9·22$, $c = 13·18$ Å, $\beta = 106° 30′$; , $\rho_{calc.} = 2·74$, $\rho_{obs.} = 2·72$. The atomic para- s Hg (0, 0, 0·250); S_I (0·109, 0·171, 0·403); 166, 0·463, 0·425); S_{II} (0·183, 0·850, 0·232) determined from F^2 and F projections on the d yz planes. These three compounds form a notropic series, changes in the structures being tioned by the metal-N and metal-S bonds.

A. L. MACKAY

548.736.5

Crystal structures of thiocyanates. VII. The l structure of the complex tetrathiocyanate of m. Z. V. ZVONKOVA. *Zh. fiz. Khim.*, **26**, *No.* 12, 7 (1952) *In Russian.*

stals of $K_2Pt(SCN)_4$ are monoclinic with space $P2_1/c$ and dimensions $a = 4·26$, $b = 12·76$, ·20 Å; $\beta = 98° 20′$. With $Z = 2$, $\rho_{calc.} = 2·78$ is the value found experimentally. From F^2 tions heavy atoms were located and $F(h0l)$ and projections gave the following atomic eters:

0, 0)	N_I (0·512, 0·823, 0·281)
0, 0·647, 0)	N_{II} (0·444, 0·052, 0·344)
760, 0·844, 0·063)	C_I (0·622, 0·832, 0·185)
764, 0·097, 0·149)	C_{II} (0·586, 0·072, 0·257)

t$(SCN)_4^{2-}$ groups were found to be planar.

A. L. MACKAY

548.736.5

The crystal structure of thiocyanates. VIII. ystal structure of the complex hexathiocyanate of m. Z. V. ZVONKOVA. *Zh. fiz. Khim.*, **27**, *No.* 1, (1953) *In Russian.*

stals of $K_3Rh(SCN)_6$ were found to be trigonal space group $C\bar{3}c1$ and dimensions $a = 7·07$ $= 22·75$ Å. $\rho_{obs.} = 2·0$ giving $\rho_{calc.} = 1·93$ for 495 hkl reflections were measured and an atterson projection followed by the correspond- urier projection gave the atomic co-ordinates. A three-dimensional Patterson section, $P(x0z)$ confirmed these. The (x, z) parameters are Rh (0, 0); K_I (0, 0·250); K_{II} (0·333, 0·148); S (0·295, 0·053); N (0·295, 0·175); C (0·295, 0·120). The Rh atoms lie at the centres of octahedra of S atoms with an Rh–S distance of $2·40 \pm 0·02$ Å. The octahedra are slightly compressed in the c-direction and the SCN groups extend from them parallel to the c-direction. The structure is related to that of $K_2Pt(SCN)_6$ which also has a layer structure with strong forces between the layers of K ions and complex ions and weak intermolecular forces in the layers. A. L. MACKAY

548.736.5

7332. The determination of the structural type of $KCo(NO_2)_4(NH_3)_2$. G. B. BOKIĬ AND É. A. GILINSKAYA. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 3, 461–4 (1953) *In Russian.*

The K, NH_4 and Tl salts with the ion $[Co(NO_2)_4(NH_3)_2]'$ (known previously to be isomorphous) were found to have the complex ion in the *trans* configuration. The K salt has the space group $P2_12_12_1$ with dimensions 11·27, 12·76 and 6·72 Å (?) and the NH_4 salt has dimensions 11·43, 12·92 and 6·73 Å (?) with the same space group. Comparison of observed and calculated refractive indices indicated the *trans* configuration. From Patterson projections the parameters (x, y, z) of the heavy atoms were found to be Co (0·161, 0·187, 0·250) and K (0·604, 0·021, 0·250). The positions of the light atoms were found by packing considerations, refinement of projections and by comparison with the Ag salt, known to be *trans* but not isomorphous. A. L. MACKAY

548.736.5

7333. The crystal structure of $KVO_3.H_2O$. C. L. CHRIST, J. R. CLARK AND H. T. EVANS, JR. Letter in *J. chem. Phys.*, **21**, 1114 (*June*, 1953).

Orthorhombic, space-group *Pnam*, $a = 8·15$ Å, $b = 13·58$ Å, $c = 3·69$ Å. The structure contains linked vanadium-oxygen chains in which the vanadium is fivefold co-ordinated by oxygen atoms. A. R. STOKES

548.736.6

7334. The structure of dicalcium silicate α-hydrate. L. HELLER. *Acta cryst.*, **6**, 724–8 (*Nov.*, 1952).

This compound, which was prepared hydrothermally from β-dicalcium silicate, is shown to have the probable empirical formula $2CaO . SiO_2H_2O$. Unit-cell dimensions are: $a = 9·34$, $b = 9·22$, $c = 10·61$ Å $Z = 8$. Space group, $P2_12_12_1$; pseudo space group, *Pbca*. The structure deduced, which is an idealized approximation to the true structure, contains discrete $(SiO_3 . OH)^{3-}$ tetrahedra and has the formula $Ca_2(SiO_3OH)OH$. A.

548.736.6

7335. The crystal structure of epidote, $Ca_2Al_2FeSi_3O_{12}(OH)$. N. V. BELOV AND I. M. RUMANOVA. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 5, 853–6 (1953) *In Russian.*

The unit cell of epidote was found to be monoclinic, space group $P2_1/m$, with dimensions $a = 8·89$, $b = 5·62$, $c = 10·23$ kX and $\beta = 115° 24′$, with $Z = 2$, in agreement with previous authors. 350 $h0l$ reflections were observed and sign determination methods were applied to them. Zachariasen's method used directly gave almost all signs positive and repeated

the Patterson projection, but the strict Harker–Kasper inequalities gave 125 signs (signs for 3 planes had to be selected), and following that, the application of Zachariasen's method led to 170 other signs. The resulting Fourier projection with 295 out of 350 observed reflections satisfactorily located most atoms. Columns of Al-octahedra with shared edges run parallel to *b*, single Fe-octahedra being associated with Al_I columns and Ca-polyhedra with Al_{II}. Both SiO_4 and Si_2O_7 groups occur joined to both types of Al columns. The formula can be written $Ca_2FeAl_2O(OH) . Si_2O_7 . SiO_4$. Atomic parameters (x, y, z) in hundredths of the cell edges are: Al_I (0, 0, 0); Al_{II} (0, 0, 50); Fe (29·6, 25, 22·6); Ca_I (76·0, 75, 15·0); Ca_{II} (60·5, 75, 42·2); Si_I (33·8, 75, 4·8); Si_{II} (68·5, 25, 27·8); Si_{III} (18·5, 75, 31·8); O_I (23·3, 0, 4·2); O_{II} (30·9, 0, 35·8); O_{III} (80·0, 0, 33·6); O_{IV} (4·6, 25, 13·1); O_V (3·5, 75, 14·2); O_{VI} (7·0 ,75, 41·5); O_{VII} (51·5, 75, 18·5); O_{VIII} (53·5, 25, 31·0); O_{IX} (62·8, 25, 10·0); OH (7·0, 25, 41·5). A. L. MACKAY

548.737

7336. The crystal structure of metallo-organic compounds. II. X-ray investigation of the crystal structure of tetraphenyl compounds of silicon, tin and lead. I. G. ISMAILZADE AND G. S. ZHDANOV. *Zh. fiz. Khim.*, **26**, *No.* 11, 1619–30 (1952) *In Russian.*

By heavy atom techniques the structures of the isomorphous series of compunds $M(C_6H_5)_4$ were determined. With the M atom at (0, 0, 0) in the tetragonal unit cell the positions of the phenyl groups are expressed in terms of parameters ϕ, the angle between the M-phenyl group bond and the *x*-axis, and ψ, the angle through which the phenyl groups are rotated from the *xy* plane. For M = Si (was found to be (8° ± 1, −37° ± 2), for M = (7° ± 1, −42° ± 2) and for M = Pb (5·5° −50° ± 3). In the Si compound the C–Si–C angle is deformed by 5½°. See also Abstr. 555 (1 A. L. MA

548.737 : 539

7337. The crystal and molecular structure of m acid. M. SHAHAT. *Acta cryst.*, **6**, 763–8 (*Nov.*, 1

Maleic acid (*cis* ethylene dicarboxylic $(CH.COOH)_2$) crystals were prepared from ace in a new habit, platy on (001). The structu monoclinic, $a = 7·47$, $b = 10·15$, $c = 7·65$ Å, 123·5°, $\rho = 1·599$ g.cm^{-3}; $P2_1/c$, 4 asymm molecules per unit cell. The structure consist nearly flat molecules arranged in layers parall the (002) cleavage planes. The molecule has equ lent C–C bonds of lengths 1·45 ± 0·02 Å, expanded equivalent C–C–C angles (125° ± 1°). two carboxylic groups are on one side of the ce C–C bond and have similar structures with alterna carboxylic oxygen atoms (C = O 1·21, C — 1·27$_5$Å). An intramolecular hydrogen bond (chela of length 2·46 Å was found, so that the molecul effectively a six-membered ring structure. N bouring molecules in a layer are linked by hydr bonds (length 2·75 Å) to form rows nearly pa to [100]. Rows in the same layer are interlinke long hydrogen bonds (2·98 Å). This forms a sy of bifurcated hydrogen bonds. The layers are together by van der Waals forces only.

548.74 : 53

Techniques for the electron microscopy of crys *See Abstr.* 7205

GEOPHYSICS 55

550.34

7338. On high-frequency seismometry. G. A. GAMBURTSEV. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 5, 787–9 (1953) *In Russian.*

Describes experiments made in Northern Tien Shan using the reflected wave method and frequencies of 10–30 c/s. It is shown that reliable results can be obtained with these higher frequencies. J. M. HOUGH

550.34 : 534.647

7339. Theory of the combination seismograph. M. WEBER. *Z. angew. Math. Phys.*, **4**, *No.* 1, 57–81 (1953) *In German.*

This instrument consists of several seismographs arranged in series or in other combinations, each element having its own (electronic) amplification system. The essential features and mode of operation are outlined, followed by a general theoretical treatment which indicates the conditions necessary to obtain a precise instrument. Four instruments are depicted and a description is given of the 2-stage electronic amplifiers used in conjunction with them. H. J. H. STARKS

550.38 : 523.746

Control of geomagnetic activity by sunspots. *See Abstr.* 6425

550.385 : 523

7340. Correlation of magnetic M-storms with monochromatic corona. R. MÜLLER. *Observa* **73**, 75–7 (*April*, 1953).

If there are no significant sunspot phenomena the sun, a maximum of magnetic activity is foun occur 3·7 days before the central meridian pas of a solar region of high coronal intensity; or, days after the appearance of bright coronal emis at the east solar limb (in agreement with ea results of Roberts, Shapley and Trotter). A sim effect is found for the minimum epochs of phenomena. A. I

55

7341. Instrumentation for geophysical explorat D. H. CLEWELL, R. A. BRODING, G. B. LOPER, S HEAPS, R. F. SIMON, R. L. MILLS AND M. B. DOB *Rev. sci. Instrum.*, **24**, 243–66 (*April*, 1953).

Discusses the various instruments used in search for oil and describes typical examples seismic, gravity and magnetic apparatus. Meth for well logging are also discussed and in partic two forms of electrical and two forms of radioac logging are illustrated. J. M. HO

550.834 : 534.41

ustic prospecting. *See Abstr.* 5930–1

550.837.3

The influence of the time lag of electric its in the earth on the measurement of the field in ic depth sounding. A. N. TIKHONOV AND B. S. SHTEIN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 5, (1953) *In Russian.*

experimental investigation of the way in which g of the potential pulse on the current pulse in ormal four-electrode method of resistivity survey nces the answer in the case of a long baseline. hown that with the normal arrangement an error to 88% can be produced for a 10 000 m baseline.

J. M. HOUGH

550.837.3 : 538.522 : 621.396.611.3

Transient coupling in grounded circuits. WAIT. *Geophysics*, **18**, 138–41 (*Jan.*, 1953).

nsient coupling between insulated circuits of length grounded at their end points in an te homogeneous and conducting medium is tigated. The general result is applied to the case typical electrodal array as used in electrical ivity logging in wells or drill holes. A graphical ple shows how the voltages build up to their value due to a suddenly applied current. A.

550.837.6 : 538.311

Electromagnetic fields of current-carrying in a conducting medium. J. R. WAIT. *Canad. J.* , **30**, 512–23 (*Sept.*, 1952).

e fields of a finite wire carrying a harmonically varying current are calculated for the case of the contained in an infinite conducting medium. insulation of current-carrying wires in a con- ng medium is discussed. It is concluded that insulation characteristics need not usually be dered. The fields of a finite current-carrying al wire within a horizontal slab are calculated. mutual impedance between two finite circuits, being vertical and within the slab and one ontal and on the surface of the slab, is calculated miting values of the lower medium conductivity. results are thought to be applicable to electrical ods of well logging in geophysical exploration. A.

550.837.6 : 538.52

Mutual inductance of circuits on a two layer J. R. WAIT. *Canad. J. Phys.*, **30**, 450–2 ., 1952).

general formula is derived for the mutual in- nce of ungrounded insulated wires lying on the ce of a two layer earth with a small conductivity ast between the layers. A.

551.46 : 539.155.2

Tertiary ocean bottom temperatures. C. IANI AND G. EDWARDS. Letter in *Nature don*] **171**, 887–8 (*May* 16, 1953).

e method of determining palaeotemperatures by atio of oxygen-18 to oxygen-16 in the calcium onate of fossil shells has been applied to a core ned by the Deep-Sea Swedish Expedition -48 in the eastern central Pacific at a depth of m. The core contained Tertiary sediments of able Oligocene age. Temperatures were determined for three locations in the core and values of 10·3, 11·5 and 9·4°C were obtained with an error of 0·5°C.

J. M. HOUGH

ATMOSPHERE . METEOROLOGY 551.5

551.501.8 : 621.396.11 : 621.317.79

7347. Instrumentation for measuring changes in phase of ionospheric echoes. R. E. JONES. *Rev. sci. Instrum.*, **24**, 433–6 (*June*, 1953).

A method is described for detecting changes in the phase under the envelope of radio pulse echoes reflected from the ionosphere and for making a continuous record of the variations of this phase with time. The system is essentially a frequency convertor, radio-frequency interferometer and recorder. A.

551.510.41

7348. Meteorological variations in the quantity of atmospheric ozone over Edmonton (lat. 53° 34′ N. long. 113° 31′ W.). E. H. GOWAN AND R. E. LEPPARD. *Canad. J. Phys.*, **31**, 702–13 (*July*, 1953).

Observations were made from August 2, 1950, to December 31, 1952. The expected seasonal variation occurs, along with large short-term fluctuations. High values in all seasons are associated with relatively low temperatures, and low ozone values are accompanied by relatively higher temperatures. It is not yet possible to judge the degree to which the transport mechanism is responsible for ozone change, but it seems to play a large part over central Alberta. A.

551.510.535

7349. The ionosphere during the partial eclipse of the sun on August 20, 1952, at Buenos Aires. I. RANZI. *Alta Frequenza*, **22**, 59–71 (*April*, 1953) *In Italian.*

It was ascertained that (*a*) in the *F*1-region the disappearance of the free electrons was due mainly to ionic re-combination; (*b*) in the *F*2-region the electronic density increased initially and then fell; (*c*) the *F*1- and *F*2-regions became sharply separated; (*d*) during the occultation of two spots the critical frequencies decreased rapidly in both regions.

L. PINCHERLE

551.510.535 : 537.564

Experimental studies of the motions of slow electrons in air with application to the ionosphere. *See Abstr.* 6901

551.510.535 : 537.568

Determination of the coefficients of recombination of the ionosphere. *See Abstr.* 6903

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 6974–6

551.510.535 : 550.384

7350. The morphology of the ionospheric variations associated with magnetic disturbance. I. Variations at moderately low latitudes. D. F. MARTYN. *Proc. Roy. Soc. A*, **218**, 1–18 (*June* 9, 1953).

A study is made of the variations in the heights and densities of the ionospheric regions, particularly the F_2 region, during magnetic disturbance. Data from

three observatories in moderate latitudes, namely Watheroo, Canberra and Washington are used, and the disturbance variations in both local time and storm time are exhibited. The former variations are found to be mainly diurnal in type; the latter are appreciable for about three days after the commencement of the magnetic storm. The initial shape of the curve of storm-time variation depends markedly on the local time of commencement of the magnetic storm. A theory of these variations is developed, according to which all ionospheric disturbance variations are due to the effect of an electrostatic field which is developed in the auroral zone, and spreads over the earth through the ionosphere in such a way as to produce the current responsible for the disturbance daily magnetic variations. The interaction between these currents and the earth's magnetic field produces a drift in the ionization of the ionospheric regions. This drift is held to be directly responsible for the observed ionospheric variations. Thus all ionospheric disturbance variations, and also the world-wide disturbance magnetic variations, are attributed to a single cause, the electrostatic field produced by the intense impressed current system in the auroral zones. A.

551.510.535 : 621.396.11

7351. Storm phenomena in the ionosphere. E. APPLETON. *Arch. elekt. Übertragung*, **7**, 271–3 (*June*, 1953).

Recent advances in knowledge of *F*2-layer ionospheric perturbations accompanying magnetic storms are summarized. It is shown that these perturbations are subject to a marked diurnal control. Differences between phenomena at high, medium and low latitudes are identified, while an attempt is made to relate ionospheric storm phenomena in medium latitudes to the geomagnetic distortion of the *F*2-layer previously identified by the writer. For this range of latitudes it is shown that the effect of a storm is to enhance the magnitude of the geomagnetic distortion already present. A.

551.510.535 : 621.396.11

7352. Characteristics of the ionosphere. Observed in Great Britain 1930–1946. *Radio Res. Special Rep.* [*London*] *No.* 23, 16 *pp.* (1953).

551.510.535 : 621.396.11

7353. Mechanical model of the ionosphere. B. A. RØRHOLT. *Tekn. Ukeblad*, **100**, 531–7 (*June* 18, 1953) *In Norwegian.*

A comparison of the expression for the refractive index for radio waves in the ionosphere and the velocity of a sphere rolling on a non-horizontal grooved rail in relation to its initial velocity suggested construction of a mechanical model. The errors are discussed, the apparatus is described and illustrated, and the application to a demonstration of reflection at normal incidence, for various wavelengths (by varying the initial velocity), and to oblique incidence, is given. J. A. WILCKEN (R)

551.521.13 : 523.72

Solar radiation and its measurement. *See Abstr.* 6421

551.521

7354. The infrared transmission of atmosphe windows. T. ELDER AND J. STRONG. *J. Franklin In* **255**, 189–208 (*March*, 1953).

Describes an approach to the practical problem infrared atmospheric transmission, and compa published data. The method separates water vap band absorption, on which there appears to be gene agreement, from the less tractable continuous atten tion by fog, haze and smoke. This separation effected by a smooth envelope curve drawn tangent the principal maxima in the observed transmit spectra. In each window, the monochromatic tra mission at the window peak is shown to be rep sentative of the effect of continuous absorption on total transmission in the window region. A sim empirical relation is developed to represent dependence of the band absorption on the water p for each window. The dependence of continu attenuation upon the water path for clear atmosph is described, and the effects of haze, fog and smo are very briefly discussed.

551.57

7355. Bursting of thin films and condensation nuc L. FACY. *J. sci. Météorol.*, **3**, 86–98 (*July–Sept.*, 19 *In French.*

Electron microscope analysis of sea spray obtai when bubbles burst, reveals the composition of c densation nuclei in different size ranges, as well the relative and absolute nuclei size distributi Mechanics of formation and bursting of bubble films, of collecting and photographing and, fina of analysis are described and illustrated. Theory drop shattering is treated in detail and natu description compared with description of artifici produced films in the laboratory. Many excell photomicrographs are reproduced. The conclus is that bursting produces numerous liquid dr between 10^{-2} and 10^{-2} cm composed of $MgCl_2$, v relatively few NaCl nuclei in the lower ra Between 10^{-4} and 10^{-3} the nuclei are nearly alw surrounded by $MgCl_2$, with sometimes NaCl more rarely with sulphates or carbonates of Na or as nuclei. It is estimated that the rate of sea nuclei production on the earth is 10^5/cm^2/sec. METEOROLOGICAL ABSTRA

551.57

7356. Remarks on formation of ice nuclei in the fr supersaturated region. C. JUNGE. *Arch. Mete Geophys. Bioklimatol., A*, **5**, *No.* 1, 44–55 (19 *In German.*

Author attempts to bring the modern theorie the operation of freezing nuclei into accord with observed fact that most condensation nuclei are pa soluble and partly insoluble. He suggests that nu are only effective in dilute solutions, and distingui between those used in the condensation process smaller ones which are not (Findeisen's type and II). METEOROLOGICAL ABSTRA

551.590.21 : 551.524.7 : 551.51

7357. Warming of the stratosphere by solar e tions (advance communication). F. BECKER. *Meteorol.*, **4**, *No.* 10–12, 487–92 (1951) *In Germa* Six-hourly thicknesses 300–1000 and 100–200

nover and Schleswig 1949–50 were compared solar activity, magnetic character figures and of $F2$ layer. Thickness of 100–200 mb showed ve correlation with chromospheric eruptions ae) and associated wave and particle radiation adio fading; sudden eruptions were quickly ed by warming of the stratosphere but anism of relation is not yet clear.

METEOROLOGICAL ABSTRACTS

551.593.55

Variations in the intensity of the oxygen lines Å and λ6364 Å during the morning- and evening-ht. P. BERTHIER. *C.R. Acad. Sci.* [*Paris*] **236,** 5 (*April* 20, 1953) *In French.*

rves correlating the line intensities and the ion of the sun under the horizon are given for vations carried out in summer 1952 at the vatoire de Haute Provence with Cojan's two- spectrograph ($f/0{\cdot}65$, 347 A/mm at λ6300 Å, zenith distance, azimuth of the rising or setting 03aE plates exposed for 5–20 minutes). Notice- differences from one day to the next are found, ner with a significant asymmetry of the morning- evening-twilight curves. The calculated heights aximum intensity are between 90 and 100 km.

A. BEER

551.593.55 : 551.593.9

On the emission of near infrared OH and O_2 in the twilight and night sky. P. BERTHIER. *Acad. Sci.* [*Paris*] **236,** 1808–10 (*May* 4, 1953) *ench.*

otometric measurements between dusk and dawn liscussed. The intensification of O_2 and, to a degree, OH bands in the evening twilight is con- d. During the period January to March 1953 matic variations have been recorded in the course e night.

A. BEER

551.593.9

Photometric study of the u.v. region of the -sky light. D. BARBIER. *Ann. Astrophys.*, **16,** , 96–128 (1953) *In French.*

detailed discussion of the results obtained with utomatic recording p.e. photometer installed at laute Provence Observatory [see also Abstr. 4512)]. Intensity measures in the u.v. are corrected liffused skylight [Abstr. 5249 (1953)], a major ibution to this region of the spectrum.

D. R. BARBER

551.593.9 : 523.6

mparison of cometary and upper-atmosphere ra. *See Abstr.* 6418

551.594.12

The ionic equilibrium of the lower atmosphere the theory of recombination. B. VITALE. *Ann. s.*, **5,** 257–71 (*April*, 1952) *In Italian.*

e assumptions used in the study of ionic balance xamined as well as their applicability to the study e low atmosphere. A similar analysis is con- d on ion recombination theories and on the etical expressions of the recombination coeffi- s. With the use of particular assumptions, onships between limit ionic densities, recom- ion coefficients and some meteorological agents responsible for the equilibrium, namely temperature and condensation nuclei size, are obtained.

A.

551.594.14 : 539.172.4

7362. The path of an atomic explosion aerosol. W. HERBST AND K. PHILIPP. Note in *Naturwissenschaften*, **40,** *No.* 2, 54 (1953) *In German.*

Experiments at Wittental show that during October 16–24, 1951, a high value of the radioactive background was discovered. A similar high value had been reported at Helena in Montana, U.S.A., between October 6–16, 1951. It is suggested that the same air mass was at these two places at the different times and that radioactivity measurements permit the path of the air mass in which the explosion occurred to be plotted.

J. M. HOUGH

551.594.14 : 539.172.4

7363. The path of an atomic explosion aerosol. Remarks on the communication of W. Herbst and K. Philipp. A. SITTKUS. **Reply to the foregoing remarks of Mr. Sittkus.** W. HERBST AND K. PHILIPP. Notes in *Naturwissenschaften*, **40,** *No.* 6, 198 (1953) *In German.*

See preceding abstract. No comparable effect was detected on other Geiger counters in the same neighbourhood at the time when Herbst and Philipp recorded the effect they believe due to an atomic bomb. In reply these authors point out that they used thin-walled counters to detect β-radiation, whereas Sittkus used tubes suitable for detecting the penetrating component of cosmic rays.

J. M. HOUGH

551.594.221 : 550.372

7364. Geoelectric investigation for the determination of lightning risks. V. FRITSCH. *Geofis. pura appl.*, **22,** 237–50 (*April–June*, 1952) *In German.*

Published information is summarized purporting to show that the incidence of lightning discharges to earth is affected by geoelectric properties of the earth. Resistivity maps of Austria are reproduced illustrating the soil resistivities at depths of 5, 10 and 50 metres. A danger factor is derived describing the expected risk of damage by lightning.

R. H. GOLDE

551.594.25

7365. Development of a charged water droplet in a cloud above freezing level. M. PAUTHENIER AND R. COCHET. *Rev. gén. Elect.*, **62,** 255–62 (*May*, 1953) *In French.*

A theoretical examination is given of the coefficient of capture by an electrified water droplet. The rate of its growth and the min. charge required by the droplet are determined. The effects are examined which the results obtained may have on the problem of natural precipitation as well as the artificial seeding process of clouds.

R. H. GOLDE

551.594.5 : 535.33.07

A rapid-scanning auroral spectrometer. *See Abstr.* 6603

551.594.7 : 621.396.821

7366. Atmospherics. R. RIVAULT. *Onde élect.*, **33,** 165–72 (*March*, 1953) *In French.*

Summary of papers and discussion presented to Commission IV (Atmospherics) at the 10th General

Assembly of U.R.S.I. (Sydney 1952). Subjects dealt with are: study of lightning; microstructure of individual atmospherics (forms, "whistles"); mean level and spectrum; direction finding of atmosph analysis of air masses—localization of storm ce radio noise of terrestrial origin. G. M. BROW

PHOTOGRAPHY 77

771.5 : 537.312.5

Silver bromide polycrystalline film prepared by precipitation method for photoconductive measurements. *See Abstr.* 6799

771.534.55

7367. The resolving power of photographic material to ultraviolet light. I. I. BREĬDO. *Zh. tekh. Fiz.*, **22**, *No.* 3, 508–14 (1952) *In Russian.*

The increased resolving power in the transition from the visible to the ultraviolet is connected with the increased absorption of light in the sensitive layer, and the decrease in scattering. The increased absorption leads to a decrease in the effective thickness of the emulsion as confirmed by micro-slice examination of the developed layer. The resolving power in the ultraviolet region does not vary much for values of layer thickness which cause a decrease in the blue region of the spectrum. W. BARDSLEY

778.33

7368. An improved historadiographic apparatus. J. J. CLEMMONS AND M. H. APRISON. *Rev. sci. Instrum.*, **24**, 444–54 (*June*, 1953).

A method whereby the mass of biological structures as small as one micron in diameter can be determined. The improved apparatus enables ten historadiographs to be taken within an hour. The versatility of the apparatus and the ease of operation suggest a wide application for its use in pathology and histochemistry. A.

778.34 : 537.534.75

General calculation of the range-energy relationship for particles in any emulsion or in a medium of any stopping power. Numerical application to the Ilford C2 emulsion. *See Abstr.* 6869

778.34 : 537.533.8

The energy loss of a fast charged particle by Čerenkov radiation. *See Abstr.* 6850

778.34

7369. Non-uniform track shrinkage in nuclear emulsions. J. R. HORAN. Letter in *Phys. Rev.* 717 (*May* 15, 1953).

Measurements of the range of mono-ener α-particles as a function of the angle of inci in Eastman NTA and NTB plates show that emulsion shrinkage is non-uniform. The correction for emulsion shrinkage should be restr to particles having an angle of dip of less than the error in the range measurement is to be less 2%. A. C. CO

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7370. The ratio of plateau to minimum grain de for electrons. R. P. MICHAELIS AND C. E. VI Letter in *Phys. Rev.*, **90**, 723 (*May* 15, 1953).

The mean grain densities have been measure electrons of mean energy 293 MeV and 2·8 recorded in a 200 Ilford G5 emulsion, giving a of 1·087 ± 0·010 for the ratio of the grain dens in the plateau and minimum ionization regions. A. C. CO

778.34 : 778.4 : 537

7371. Stereoscopic cameras for use with a W cloud chamber. K. R. ALLEN, M. LIPSICAS, W WILLIAMS AND D. FOTHERINGHAM. *Rev. sci. Instr* **24**, 501–4 (*July*, 1953).

A design of stereoscopic cameras for use in inv gating large angle scattering phenomena with a W cloud chamber has been developed. Duplicatio projection systems was adopted in order to en the analysis of tracks to be shared between two te working simultaneously. It was required that reprojected images of the two pairs of cameras sh be identical to within close limits, in addition to usual requirements of a high order of accuracy reprojection of each camera. Tests described in paper showed that the reprojection was accurat at least ±0·5 mm, which is within the allo tolerances of the experiments envisaged. No ob vable differences were found between the reproje images of the two pairs of cameras.